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THE EDISON INCANDESCENT LAMP CASE.

JUDGE WALLACE, in granting an injunction against the United States Electric Lighting Company for infringement of Edison's lamp patent, said that in none of the lamps prior to Mr. Edison's French and English patents of 1879, had any attempt been made to make the vacuum chamber wholly of glass with the parts sealed together by fusion, or to seal the conducting wires leading to the burner through the glass by fusion of the glass. The impracticability of maintaining a carbon burner under such conditions that it would be sufficiently durable, had apparently so impressed those who were studying lighting by incandescence, that we find as late as the early part of 1879, both Lane-Fox and Edison trying to perfect a burner of other material.

The specification was addressed to those who were skilled in the art to which it relates; who appreciated the advantages of arranging the lamps in a system of multiple arc, and of providing the lamp with a burner of high resistance and small radiating surface; who knew how high resistance, both specific and total, is imparted to a conductor; who knew that the rods, pencils, or other forms of carbon burners previously used had not been designed to embody the principle of high resistance; who knew how desirable it was to maintain the burner in a perfect vacuum, or in gases that would exclude oxygen; who knew what had been attempted and had proved impracticable; who knew that such materials as are mentioned in the specification (even the tar-putty compound seems to have been used in Gauduin's process) would compose a carbon of high resistance when subjected to a proper process of carbonisation; and who knew how to practice proper processes for the carbonisation of such materials. Read by those having this knowledge, the radically new discovery disclosed by the specification is that a carbon filament of extreme tenuity can be made with a high resistance and be absolutely stable when maintained in a perfect vacuum. The judge decided that the defendants did not infringe the first claim of the Edison patent, because the leading wires in its lamps are not secured to the filament according to the method of the patent, that is by cement carbonised *in situ*, but by clamps such as the specification condemns. The second claim is broad enough in its phraseology to secure the real invention described in the specification, and can be read consistently with its language so as to import into it every essential limitation. Mr. Edison is entitled to the credit of obviating the mechanical difficulties which disheartened other inventors, but what he did in this respect was a matter of secondary merit, and was no longer new in the art. What he actually accomplished was to be the first to make a carbon of materials and by a process which was especially designed to impart high specific resistance to it, the first to make a carbon in the special form for the special purpose of imparting to it high total resistance; and the first to combine such a burner with the necessary adjuncts of lamp construction to prevent its disintegration and give it sufficiently long life. By doing these things he made a lamp which was practically operative and successful, the embryo of the best lamp now in commercial use, and but for which the sub-division of the electric light by incandescence would still be nothing but the *ignis fatuus* which it was proclaimed to be in 1879 by some of the learned experts who are now witnesses to belittle his achievement, and show that it did not rise to the dignity of an invention.

In the judge's opinion anything that is a filament is covered by the second claim, provided that the filament have sufficiently high total resistance for efficient use when the lamps are arranged in multiple arc, and to be used with leading in wires of platinum. In fact, what was a rod before the date of Edison's patent is converted by that document into a filament, and, in consequence, no longer available for use by the public at large.

Although Mr. Edison distinctly says that the filament should have a resistance as high as 100 ohms, the patent must not be interpreted in a literal sense, for the reason that a patent has been sustained for an invention the full significance of which was not appreciated by the inventor when it was made—the Bell telephone being a case in point.

To arrive at this conclusion in respect to the carbon filament of the lamp, the Court had to declare it almost preposterous to argue that the substitution of the carbon filaments for the platinum burner of the former lamp was an obvious thing to electricians, but had to admit that it would have been so had there been a filamentary carbon in the prior state of the art; the Farmer ribbon-shaped carbon burner is pushed out of the way as not being a part of the prior art, but merely an isolated example known to a select few.

It is obvious that a man being in possession of a ribbon carbon would, if required, reduce the width of the ribbon and produce a high resistance filament, and it would be quite as consistent to make the low resistance ribbon carbon cover a high resistance attenuated carbon, as it is for the Court to decide that the high resistance Edison filament embraces the low resistance burner which had been invented long before Edison came on to the scene.

In the interpretation of patents, the judges frequently seem to set a premium upon ignorance, and allow some claim—which may be indefinite in a practical sense, but whose phraseology broadly covers everything—to swallow up and include every advance that has been made in the art by prior inventors.

We presume, however, that the present decision in the lamp case will not be accepted by the defendants without further struggles.

THE PETROLEUM ENGINE COMPANY, LIMITED.

THE annual report of this company may soon be expected, the last one being dated August 20th, exactly eight days before the date of the meeting then called, and it, therefore, brings to one's mind the length of time which has elapsed since the formation of the company, and the fact that, notwithstanding the immense opportunities for sound business in petroleum engines, such as are made under its patents, no dividend has yet been declared.

Why is this? Well, just at this moment Mr. J. Stovin, of the National Conservative Club, who claims to be the largest shareholder of the company, comes forward to tell us. In a circular, which we received only this week, and which we assume was issued to the shareholders at the same time, he points out that hitherto the company has been a manufacturers' company, and that the makers of the engine, who, by the way, have a relative on the board of directors, have managed to retain a virtual monopoly, although the directors, by the articles of association, have full power to let to, to contract with, and grant licenses to other firms, entirely independent of the Messrs. Priestman, for the manufacture of the company's machinery and the various types of engine.

Now, is it not a fact that the directors have allowed the whole of the business to be carried on by Messrs. Priestman, the manufacturers, and is it not conducted wholly in the name of that firm? If so, when the company's patents are run out, where will be the Petroleum Engine Company? Will it not be extinct, and will not Messrs. Priestman be in possession of the business?

If the directors cannot see this, it is time for the general body of shareholders to appoint others who can better look after their interests.

It would be interesting to know if anything has been done to develop a business in the engine in connection with tramcars and launches, and if not, why not? Possibly the agreement with Messrs. Priestman may be referred to, but in that case it becomes the more apparent why such powers of making or marring the fortunes of the company should be confided to any one firm, when the directors of the company had a free hand to grant other licenses, and it becomes more than ever necessary to protest against the board of directors comprising relatives, by marriage or otherwise, of the Priestman family.

With regard to the colonial patents, again, what amount of royalties has been received under them? To what extent have engines been sent out to the colonies? Have any steps been taken either to dispose of these patents, or to license their use? Is it worth while for the company to maintain these patents, if the board cannot see its way to profit by their possession? Can nothing profitable be achieved in Canada, the Cape of Good Hope, India, Ceylon, New South Wales, South Australia, Tasmania, Queensland, or New Zealand?

We think the shareholders will do well to support Mr. Stovin by their proxies, or by their presence at the meeting, for the more one considers the case the more evident it is that prompt inquiry and prompt steps are necessary to prevent the company from dwindling to an early extinction, which extinction will greatly facilitate the upraising of a splendid business to the benefit of others.

We should like much to know upon what basis it was decided that of the 10 per cent. formerly payable to Messrs. Crossley Bros. for royalties up to May of last year, 7½ per cent. should be retained by Messrs. Priestman Bros. and only 2½ per cent. by the company.

There is another question we should like to have satisfactorily answered, namely, what enquiry, if any, has been made as to whether the cost of manufacture has been kept at as low a figure as possible. Did the company ever enquire, or send its engineer to enquire, at the works if the plant employed and the methods adopted were of the most modern and effective kind?

The shareholders will have at the forthcoming meeting a good chance of rescuing their jeopardised property—if they fail to avail themselves of that chance it will probably be the last that will present itself.

ELECTRICAL LEGISLATION IN GERMANY.

THE German Telegraph, Telephone, and Electric Lighting Bill has not yet reached its second reading, and it is expected to meet with serious opposition on the part of the Liberal Party in the next sitting of the Imperial Diet, this party being opposed to State monopoly. A few days ago the *Kreuz Zeitung* published an article on the fight of the electricity works against the telegraph bill, it being stated that private electrical works were of no use, and that an extensive transfer of a monopoly to the State was the only hope of the future. On the other hand, the *Freisinnige Zeitung*, the

organ of the Liberal party, fears that a State telephone monopoly would be dangerous to future interests. The proposed legislation, says the *Kolnische Zeitung*, scarcely threatens the position of electricity, but almost exclusively telegraphy and telephony ; it does not intend that the usefulness of electricity works shall be diminished, but rather that, with certain limitations, the monopoly of the telegraph and telephone service shall be assured to the State.

Continuing, the Cologne paper states that all parties recognise the justification for a State monopoly of telegraphy. As to telephony, an erroneous impression has been circulated that this means of communication is only of local importance. This is incorrect. Telephony has almost ousted telegraphy in some towns, and as far as long distance transmission is concerned, the number of telephonic conversations between Berlin, Hamburg, Leipzig and Breslau is, in proportion to the number of wires, equally as many and important as the service in inner Berlin. Thus it is incorrect to regard telephony as only of local importance ; it should be compared with telegraphy, and it requires the same efficient working. According to the project of the Commission, private individuals have the right of erecting on their own property telegraph or telephone installations, even should the property extend 15½ miles ; apart from cases of this kind, it is essential that telephony should be in the hands of the State.

In referring at some length to electricity works, the same paper urges that they should bow to the older industry, and employ a double-wire system. If the State employed a metallic return throughout, it would necessitate the expenditure of £1,500,000, which would render the telegraphic service more expensive, and interfere with international treaties. Electricity works (presumably for traction purposes) should, for that and other reasons, be compelled to use a metallic circuit throughout.

THE FRENCH RAILWAY ACCIDENT.

FIFTY killed, and over one hundred injured! Such is, as we write, said to be the result of this most terrible and heartrending accident. With but a time interval between them, these two heavily laden trains—laden to the brim—upper and lower compartments of every vehicle filled—packed with their human freight—came into collision, the colliding train rushing upon and crushing beneath its wheels the hindermost portion of the preceding train with its holiday occupants.

The scene is too harrowing to contemplate, and it is not our desire to do more than at present refer to it in the most cursory manner. When the enquiry has been gone into, and the absolute facts leading up to the unfortunate result have been ascertained, we hope to again return to the matter. So far it would appear certain that there was an insufficient means of controlling the movement of the trains, that the action of the signals was not so definite or reliable as should have been the case, and that the horrors of the scene and the dire results of the collision were greatly increased by the fact that the gas reservoirs of one or more of the crushed vehicles were ignited and exploded.

In a previous article, when discussing the question of train lighting, and in dealing with the comments on Mr. Langdon's paper, read before the Institution of Civil Engineers, we drew attention to what may now be regarded as the prophetic observations of Sir Frederick Bramwell.

When taking part in that discussion, Sir Frederick pointed out that the possibility of such an accident as that which we now have before us formed the groundwork of his objection to the use of gas for lighting railway passenger vehicles. He witnessed the result of the South Wales accident, and feared the possibility of its recurrence, attended by possibly worse results. Although the subject was one which must have claimed consideration by others, Sir Frederick's was the only voice uttered in this direction, although evidently the point raised by him was the most important, or, at all events, one of the most important, in the discussion. It is to be hoped that that which has occurred—happily, out of our own country—will direct more than usual consideration to the subject, not only by railway companies, but by the Board of Trade. We have always regarded the employment of gas for the lighting of trains as a most objectionable source of danger which might at any moment be brought into play with dire results. The French accident brings home to us the confirmation of our fears. Happily in England gas has not been applied to any great extent, and it need go no further. An equally, if not more brilliant form of light is to be found in electricity, which merely requires to be more fully fostered by railway companies to develop its advantages both as regards economy and comfort. It could scarcely under any circumstances be productive of such a dire disaster as that of St. Mandé.

The Coalfield at Dover.

THE promoters of the coal boring at the Channel Tunnel works at Shakespeare's Cliff, Dover, on the South Eastern Railway, have been so encouraged with the success of the operations that the boring is to be continued pending the decision to sink a shaft. The average depth of the six seams already pierced is from one to two feet, the coal strata being about seventy feet apart. As the depth is increased it is believed there will be a corresponding increase in the thickness of the seams.

The London Fire Brigade.

THE retirement of Captain Shaw from the position of Chief of the London Fire Brigade, an office which he has so honourably held for many years, will be looked upon by the inhabitants of the metropolis as nothing short of a national disaster. His popularity with all classes is undeniable, and it is much to be regretted that while still in the full vigour of mind and body he should have felt it necessary to deliberately sever his connection with the force he has so successfully commanded, and whose organisation, under his able and skilful control, is to-day the admiration of the whole civilised world. The London County Council has much to answer for, and Captain Shaw's retirement is not the least culpable of the many mistakes made by its members, but as the gallant chief of the London firemen says :—"Under the existing conditions and terms I could not continue to hold my position with advantage either to your honourable council or to myself."

ELECTRIC LIGHTING IN ABERDEEN.

THERE was issued to the members of the Gas Committee of the Town Council last week, a series of reports and other documents in reference to the "Aberdeen Electric Lighting Order, 1890." Mr. W. B. Esson, in a report to the Town Council, dated May 26th last, states that it was now proposed to begin with a plant which would be capable of supplying current for the simultaneous lighting of 1,000 lamps of 16 candle-power. Taking all things into consideration, he recommends that for a start, two machines of 500-lamp capacity be installed, with a storage battery capable of supplying current for 500 lamps simultaneously—this giving the best arrangement under the circumstances. It is to be observed that the storage here provided, which at the start acted as a reserve, was ample for the station when supplying in the future 4,000 or 5,000 lamps. It must also be noted that, though the station only supplied 1,000 lights simultaneously, about 1,500 may be fixed in the consumers' houses, as the maximum at any time lighted will only be two-thirds of those fixed. As regards the mains, the sum put down for these covers the cost of conduits large enough to permit of additional conductors being placed in them as the demand for lighting increases. With two conductors, as estimated for, the mains were large enough to carry current for 2,000 lamps; with a third conductor to be afterwards added, the mains would carry current for 5,000 lamps, which would probably reach the requirement limit of the compulsory area. In making up this change in the mains, only £1,000 would be spent, no streets having to be broken up. The cost he makes up as follows:—Two sets of engines and dynamos of 500 lamp capacity each, with controlling gear complete; engine, vertical compound, with directly coupled dynamos—£1,700; two sets of locomotive type boilers, with all donkey pumps, &c.; steam and exhaust, and water connections, also water heater, £800; accumulators, capable of giving current for 500 lamps lighted simultaneously, £1,650; mains, feeders, junction boxes, and laying same, £4,200; temporary or partially completed building and foundations, £1,000; sundries, incidentals, &c., £500—total, £9,850, or say, £10,000. The cost of consumers' meters has not been included, as these will be purchased as required, and the meter rents charged would furnish interest on the expenditure and provide for depreciation. A sum of £500 might be set aside for the purchase of meters at the start.

In a supplementary report, dated June 13th, Mr. Esson states that in his estimate of £4,200 for mains, feeders, &c., he considered only the employment of high-class India-rubber insulated cables drawn into iron pipes, the reason being that electrical engineers are more familiar with mains of this kind, while his own experience had been confined almost entirely to this class of insulation. But he had since made most careful enquiries regarding the Callender-Webber system of drawing cables insulated with bitumen compound into a conduit formed of blocks of bitumen concrete carefully cemented together—the result of his investigations being that he was now able to speak with the utmost confidence of this less costly method of insulating and laying cables.

Messrs. Callender & Co. had given an estimate for the whole work of £2,800, so that by adopting their system the estimate for the whole of the work of the lighting would stand at £8,450 instead of £9,850 as in his previous report.

The print contains two proposals—one by the Brush Electrical Company and the other by Mr. Richard Miller, Glasgow. The former proposes (1) that a local company with adequate capital should be formed by them to undertake the supply of current under the order, the capital, articles, and constitution of the company to be subject to the Town Council's approval. (2) That the company should take over all the powers, privileges, and obligations of the corporation's provisional order. (3) The period for which the transfer would be undertaken to be 21 years—the corporation having power at the end of that period to acquire the undertaking (*a*) upon paying for the undertaking as a going concern, including a valuation of the goodwill; (*b*) upon repaying the capital invested in the undertaking, plus a cumulative profit of 10 per cent. per annum upon the capital from time to time invested in the undertaking, less any dividend paid. (4) That as regards rent or other considerations it be given to the corporation in respect of the transfer, the company to be formed should either apply the profits over and above a certain percentage upon the capital expended to a reduction of price for the light, or, if the corporation preferred it, to a payment to the corporation, or partly the one and partly the other purpose. (5) As regards the system or systems adopted for the supply of electrical current, they might say that, as manufacturers of every class of electrical apparatus and as contractors for all the best known systems of electric lighting they would undertake that the company should be largely guided in the systems of supply by the technical advisers of the corporation. Speaking, however, from their experience as electric contractors on a large scale, and with their knowledge of the requirements of Aberdeen, they inclined to the view that the most suitable system of supply would be that of the continuous current for arc lighting in the public streets (which would be entirely distinct from the system adopted for private lighting), and that the system for private lighting should be that of the alternating current, at a pressure not exceeding 2,000 to 3,000 volts. (6) That as security for the due implement of an agreement with the corporation the company should deposit a fair sum to be agreed upon with the corporation upon sealing of the contract, such sum to be released to the undertakers in instalments as the work of completion of the contract progressed.

In view of these proposals the corporation are asked to enter into a contract with the company for the electric lighting by arc lamps of the main thoroughfares in the area to be lighted upon terms to be agreed on; that the corporation will undertake not to give their consent to any other provisional order or licence being granted during the term of the agreement to any other company or person within the same area of supply; and that the corporation agree not to reduce the price of gas during the term of agreement to such an extent as to seriously interfere with the business and goodwill of the company undertaking the supply of electric light.

Mr. Richard Miller states that there is not scope enough in the area to make a central electric lighting station pay. If the Town Council were willing to assign their powers under the Act, he was willing to try and start a local company to take them over, and fit up a proper station with the newest Thomson-Houston alternating plant. An arrangement could be made for either the Town Council participating in the profits after a fixed cumulative dividend and reserve fund has been earned, or a reduction in the rate charged to consumers to be made as may be mutually agreed on.

THE INSTALLATION OF THE ELECTRIC LIGHT IN THE ROYAL PALACE AT BUDAPEST.

[FROM OUR OWN CORRESPONDENT.]

As I have already informed you, the introduction of electric lighting in the palace at Budapest has been resolved on, and this new system of lighting is to be in full activity by the ensuing winter season. I can give you the following account of the particulars of this installation.

The projected arrangements include: 8 arc lamps at 16 ampères; 1,826 glow lamps at 5 normal candles; 488 glow lamps at 10 normal candles; 317 glow lamps at 16 normal candles; 22 glow lamps at 32 normal candles.

The entire installation, which is to include all rooms in the palace itself and in the so-called Stoeckel-building (an appendage) is to be carried out in two successive periods. By October, 1891, the state saloons and main stairs, as well as the private apartments of the imperial family are to be fitted up with the electric light. It will comprise 6 arc lamps at 16 ampères; 1,591 glow lamps at 5 normal candles; 321 glow lamps at 10 normal candles; 136 glow lamps at 16 normal candles; 11 glow lamps at 32 normal candles; whilst the installation of the electric lights in the remaining parts of the palace is reserved for the following year.

Hitherto, gas had only been used for lighting the corridors and the state stairs, whilst in all other parts candles have been in exclusive use. There will be here, consequently, an immediate transition from the primitive candle to the electric light. Most of the old fittings will be replaced by new "electroliers," though the lustres in the state saloons, some of which are masterpieces of rare value, will remain, and will

be adapted for electric lights. On this account it was necessary to use for the glow lamps in these lustres (all of 5 candle-power) supports imitating the form of candles.

The electric lighting throughout the palace will be very copious. This applies particularly to the state saloons, where for each candle (of about 2 normal candle-power) there will be substituted a 5 candle glow lamp. In the grand state saloon alone there will be used: 3 lustres, with each 80 lamps at 5 normal candles = 1,200 normal candles; 8 brackets, with each 19 lamps at 5 normal candle-power = 760 normal candles.

Twelve brackets with each 13 lamps of 5 normal candle-power = 780 normal candles.

Three central lustres with each 80 lamps of 5 normal candle-power = 1,200 candles, making a total = 3,940 normal candles.

It is to be remarked that this saloon has an area of 310 square metres (10 metres in breadth by 31 in length). It had been found that in this state saloon after lighting the 788 candles the temperature rose to twice its former height within 20 minutes, wherefore the candles in general were lighted at once by means of an interesting arrangement only immediately before the commencement of the festivities.

As I mentioned on a former occasion this installation will be connected with the Budapest electrical works which are about to be erected, and in the meantime they will be supplied with the electric current by the electro-technical works of the firm Ganz & Co., who have also been entrusted with the installation in the palace. The city has already sanctioned the laying down a provisional lead for this purpose which will be connected with the transformers to be set up in the palace.

For the first portion of the installation to be completed in October, 1891, 7 transformers of 10,000 watts each (or in all 70,000 watts) will be placed in a locality on the ground floor of the palace. Above the transformers is the table from which the regulation and control of the several conductive cables and their lamps will be effected and on which are placed the chief lead contacts.

The leads, altogether of 15 kilometres, are placed in two main cables so that the lamps for the principal rooms are distributed neally equally between the two cables.

CAPACITY, SELF-INDUCTION AND MUTUAL INDUCTION MEASUREMENTS ON OVERHEAD LINES.

By M. MASSIN.

THE capacity of overhead lines has not often been measured. No measurements of mutual induction or self-induction have as yet been taken, or at any rate published, with the exception of a note in the *Annales Télégraphiques* in which I described the first of these experiments.

This omission is partly explained by the difficulty experienced in finding lines on which the measurements can be conveniently effected. The conductors used for these experiments should not be attached to the same supports as the wires in use, or even to supports near them; moreover, the wires installed on the same supports as the conductors measured, or on supports near them, should not, throughout their extent, be subjected to inductive influences from other wires, or be connected to earth in offices where the service is going on at the time the measurement is being effected.

I was able to extend my experiments on capacity and self-induction over three circuits in which these conditions could be observed.

A. Line of 18 kilometres of iron wire, 3 millimetres in diameter; two wires placed at a distance of ·4 of a metre from one another and at a mean distance of 4·5 metres from the ground.

B. Line of 50 kilometres arranged under the same conditions as line A.

C. Line of 50 kilometres of copper wire, 2·5 millimetres in diameter; two wires placed at a distance of ·5 of a metre from one another and at a mean distance of 5·5 metres from the group.

We will now give a brief description of the methods employed and the results obtained.

Capacity.—The capacity was measured by comparison with a condenser, the line being charged with a given battery and the discharge sent through a galvanometer.

By virtue of a special arrangement, no interval elapsed between the moment when the battery was disconnected from the line and that in which the line was discharged into the galvanometer; we thus avoided letting part of the charge escape. With a view to preventing the effects due to earth currents, effects which have a considerable influence on wires having an insulation resistance of only a few megohms, the mean of the throws obtained was taken by interchanging the poles of the charging battery.

The experiment was made by taking the capacity of a wire connected to earth, then connecting the second pole of the battery and the outgoing wire of the galvanometer, not to earth, but to a second insulated wire, parallel to the first and attached to the same supports; we thus measure the capacity of a loop circuit. The results are as follows:—

LINE A.

	Microfarads.
Kilometric capacity when connected to earth	·0097
„ „ of the two wires together	·0070

LINE B.

Kilometric capacity when connected to earth	·0099
„ „ of the two wires together	·0069

LINE C.

	Microfarads.
Kilometric capacity when connected to earth	·0091
„ „ of the two wires together	·0065*

Calculation gives ·0067 as the capacity of one wire of the lines A or B when connected to earth.

Self-induction.—The method employed is one of those proposed by M. Vaschy in section 381 of his *Traité d'Electricité et de Magnétisme.* The effect of self-induction is neutralised by means of a condenser shunted by a resistance.

The first part of the measurement requires that strict equilibrium for the permanent current should be obtained from the Wheatstone bridge; this is arrived at theoretically by means of a stretched German silver wire along which a contact slides. Practically the best results are obtained with a fixed contact, between the clips of which passes a wire wound in opposite directions on two little drums of ebonite turned by hand.

The earth currents, which varied constantly, did not allow of our measuring the self-induction of a wire connected to earth, but only the self-induction of a loop line formed of two parallel wires.

The coefficients of self-induction were found to be:—

	Quadrant.
For line A	·0121 per kilometre.
„ „ B	·0129 „ „
„ „ C	·0025 „ „

In this third case, calculation gives ·0022.

For the two first cases comparison is useless, since the permeability of the metal enters into the calculation, and the permeability of the iron of the telegraph wires on which we experimented was not known. We can, however, deduce this permeability from the coefficient of self-induction measured; it would be about 100.

Mutual Induction.—The mutual induction of two wires was measured by a method also proposed by M. Vaschy in the work already mentioned, section 380, by comparison with a capacity.

The earth current circulating in the induced wire has the effect of bringing out the luminous image on the scale. The earth current is overcome with a shunted battery, or the image is brought back with the directing magnet.

On line A the measurements gave for the kilometric coefficient the value ·0032. These figures require confirmation.

On lines B and C the results did not show sufficient agreement to be quoted.

* The system of two wires has therefore a capacity equal to $\frac{1}{10}$ths that of a wire connected to earth. In the case of underground wires, we get exactly half.

The experiments with regard to the coefficients of self-induction require to be completed by the indication of this coefficient in the case of a single wire; to get this we must avoid the disturbances of earth currents by using a circuit consisting of a single wire, starting from an office by one line and returning by another, without the conductors constituting it following the same course as one another, or as wires in service, or being influenced by wires in service.—(*Comptes Rendus*, July 13th, 1891.)

PASSENGER SAFETY ON THE CITY AND SOUTH LONDON RAILWAY.

A MOST lamentable accident, with fatal results, occurred on Thursday afternoon of last week at the Oval Station of the City and South London Railway. About 10 minutes to 4 o'clock a well-dressed elderly gentleman alighted from a train and proceeded to a lift which he endeavoured to enter while in motion. He was carried up a short distance when he came into contact with the cross-beam, the result being that his head was completely severed, the body falling into the well beneath.

This accident is not the first which has occurred at that station. "Exactly a month ago," writes a correspondent, "I had the fingers of my left hand crushed between the bars of one of the expansible iron gates used in one of the lifts at the Oval Station, and had to immediately have my fingers dressed by a surgeon. This accident was due to my own fault directly, and I therefore made no complaint. It was, however, indirectly due to the overcrowding of the lift by the attendant, for had the lift not contained more passengers than the number (forty) specified by the company as its carrying capacity, my fingers would never have been injured. The load was so heavy that several persons were obliged to step out of the lift before the latter could be caused to ascend."

It is a singular coincidence that both the fatal and the slight accident mentioned by our informant should have taken place at the same station, and that they should have occurred on the ascending journeys. In both cases the breaking of the company's regulations by the deceased gentleman and the other party brought about the results enumerated; still, these accidents might have been avoided.

There are two improvements which the public has a right to demand to be introduced in the working of the City and South London Railway. One is that the lift attendants should receive definite instructions not to attempt to carry more than the prescribed number of passengers; and the other, that the *employés* shall no longer be permitted to "rush" passengers from the lifts into the trains and *vice versâ*. The first-mentioned point would only have to be put into practice according to traffic requirements, that is, occasionally; but the second point requires attention frequently. The manner in which the *employés* sometimes unduly hasten passengers would, we imagine, not be tolerated on any other railway. To be told, in gruff tones, to "hurry up, train now in, hurry up, lift waiting," is not well received by anybody, and the consequence is a frequent race for both trains and lifts, the scene sometimes resembling the running of boys after a fire engine in the streets. There is not the slightest necessity for this state of affairs; those passengers who are not carried by one train can be conveyed by another, and the same with the lifts. Indeed, with the latter, the attendants appear to have plenty of time to spare apart from taking up and bringing down live traffic, so that there is no necessity for the undue hurrying of passengers.

By drawing the attention of the directors to the above public grievances, we trust that the company will immediately remedy them, and thereby further ensure the safety of passengers. Cheap fares alone, apart from civility to the travelling public, will not greatly tend to increase the popularity of the line.

Just before going to press we learn that both gates are now closed before the lifts are set in motion, and that the above-mentioned officialism does not seem so prevalent.

ELECTRIC LIGHT ACCIDENTS AND THE PARIS MUNICIPAL COUNCIL.

As already stated in the REVIEW, an attempt has been made in Paris to make capital out of the accidents imputed to the electric light in that city, and now, most opportunely, has appeared a report, presented by M. Maurice Binder to the Paris Municipal Council, "On the subject of the different accidents imputable to the electricity companies or the Gas Company, which occurred in the course of 1889, 1890, and the first quarter of 1891." The report (we omit the accidents arising from the use of gas, a statement of the number of which, however, will be found below) is as follows:—

Gentlemen,—In your sitting of March 18th last, you voted the following resolution which I had the honour of submitting to you: "The Council invites the Administration to draw up a list of the accidents imputable to each of the different electricity companies and also to the Gas Company." In making this proposition my idea was unquestionably not to hinder in any way whatever the development of electric lighting in Paris, a lighting of which I have never ceased to show myself a partisan under all circumstances; but on account of the numerous accidents most often imputable to a defect in inspection and to the negligence alone of certain companies in the laying of their canalisation, I thought it was urgent to submit to you the list of the different accidents which occurred in 1889, 1890, and the first quarter of 1891, in order to enable you with this knowledge henceforth to only grant new concessions to the different companies who should agree to carry out to the letter the specification voted by the Municipal Council and modified by us after short delay in all points of a nature to ensure the public safety. The following is the information supplied me by the Direction of Works:—

WITHIN THE LIMITS OF THE PUBLIC THOROUGHFARE.

September 27th, 1889.—1, Boulevard des Capucines (facing the Vaudeville). *Probable* communication between the naked cables of a principal canalisation and a badly insulated parallel derivation: no one injured and no damage. A sort of dance by the horses passing the point indicated took place. (Edison (low tension) continuous currents.) May 16th, 1890.—23, Boulevard Poissonnière. Large escape of electricity (13 ampères) on account of breakage of the distributing cables: material damage (perforation of the conduits and gas branches). Great heat given off from the ground. (Edison (low tension) continuous currents.) October 30th, 1890.—5, Boulevard Bonne Nouvelle. *Possible* communication between the gas canalisation and the electrical conductors: small material damage (melting of a pipe from the gas main). Cause very uncertain. Electrical conductors passing four mètres from the point where the accident occurred and having given rise to no intermediary damage. (Edison (low tension) continuous currents.) December 23rd, 1890.—112 and 118, Rue de Rivoli. *Probable* communication between the gas branches and the electrical conductors: material damage, perforation of gas branches. (Popp (high tension) continuous currents.) March 22nd, 1891.—27, Rue Royale. *Probable* communication between the electrical conductors and a gas branch traversing a draught hole at the junction of the conductors with an electrical branch: perforations of the gas branches, escape and entry of the gas into the house. Serious material damage. (Popp (high tension) continuous currents.)

BEYOND THE LIMITS OF THE PUBLIC THOROUGHFARE.

September 30th, 1889.—Eden Theatre. A workman having made communication with the pole of a high tension lamp with an iron rod instead of one of an insulating material; instantaneous death of the imprudent workman. (Popp (high tension) continuous currents.) March 26th, 1890.—26, Boulevard des Italiens. Probable communication between the gas canalisations and the electrical conductors: Very slight material damage and small outbreaks of fire at two points about 30 mètres apart. (Edison (low tension) continuous currents.) June 19th, 1890.—279, Rue St. Denis. Denudation of the conductor wire of an incandescent lamp. Electric current transmitted to a rising column of gas by the different metallic portions of the front of a building. Very slight material damage and fire. (Société

de la Transmission (low tension) continuous currents.) October 1st, 1890.—71, Rue du Faubourg St. Denis. Bad installation of an electrical branch traversing a gas meter. Escapes on the branch: Small material damage. The gas meter perforated and unsoldered. (Société de la Transmission (high tension) continuous currents.) November 1st, 1890.—Grand Café, 14, Boulevard des Capucines. Excess of tension in a cable caused the melting of the insulating covering: Important material damage in the basement of the café. Burning of a distribution table; wainscot carbonised. (Popp (high tension) continuous currents.) November 9th, 1890.—76, Rue Montmartre. Contact between juxtaposed gas and electricity conduits, the latter being insufficiently insulated. Commencement of a fire with unimportant material damage (woodwork of the shopfront). (Popp (high tension) continuous currents.) November 12th, 1890.—99, Boulevard de Magenta. Same cause as in preceding instance. Unimportant material damage (perforation of a gas pipe). (Société de la Transmission (high tension) continuous currents.) December 26th, 1890.—26, Rue de la Verrerie. Probable cause, want of ventilation in the place containing the accumulators: Rather serious explosion. Three workmen injured. Material damage to the shopfront. The insufficiency of ventilation has been remedied since the accident. (Popp (high tension) continuous currents.) January 5th, 1891.—144, Avenue des Champs Elysées. Short circuit. Insulation of the electric cables worn and caught fire. Small material damage. Burning of the mouldings containing the cables. (Beau et Cie (low tension) continuous currents.) January 7th, 1891.—Brasserie Dreher. 1, Rue St. Denis. Probable cause, damaged insulation, in contact with a metal basket in the kitchen, this communicating with a gas pipe: Slight explosion of gas and slight damage to the pipe. (Municipal network (low tension) continuous currents.) February 7th, 1891.—289, Rue St. Denis. *Possible* communication between the gas conduits and an electrical branch: very slight traces of damage on a gas branch and conduit. Cause particularly uncertain. Electrical branch enveloped in a Flemish tube laid about eight months previously. Damage doubtless anterior to the laying of this tube. (Société de la Transmission (low tension) continuous currents.) March 4th, 1891.—3, Boulevard des Capucines. *Probable* communication between a gas canalisation and a juxtaposed electric conductor: slight explosion of gas and slight damage to pipe. (Popp (low tension) continuous currents.) March 4th, 1891.—5, Boulevard des Capucines. *Probable* communication between the juxtaposed gas canalisations and the electrical conductors: slight explosion of gas and slight damage to pipes. (Popp (low tension) continuous currents.)

On the other hand, on May 14th last, the Secretary of the Prefecture of Police forwarded M. Binder, with the following letter, the list of accidents verified by his Administration during the year 1890 and during the first quarter of 1891 :—"Conformably to the desire expressed in your letter of March 27th last, I have the honour to transmit to you herewith a list of the accidents verified in 1890 and during the first quarter of 1891 and caused by conductors and apparatus used in electric lighting."

ACCIDENTS VERIFIED IN 1890 AND DURING THE FIRST QUARTER OF 1891.

January 1st, 1890.—Théâtre Français. Fire in the distribution table. Wainscoting damaged. March 23rd, 1890.—3, Boulevard Bonne Nouvelle. Fire in a shop. Wainscoting damaged. March 24th, 1890.—26, Boulevard des Italiens. Commencement of a fire at two points about 30 mètres apart. (Edison Company). April 11th, 1890.—11, Rue de Valois. Fire in the partition. April 23rd, 1890.—31, Rue du Faubourg St. Martin. Fire in a shop. May 16th, 1890.—23, Boulevard Poissonnière. Material damage (perforation of conduits and gas branches). (Edison Company). June 4th, 1890.—Théâtre Français. Fire in the wires of the lustre. June 19th, 1890.—279, Rue St. Denis. Very slight material damage. Fusion.. (Société Anonyme d'Eclairage et de Force par l'Electricité). July 19th, 1890.—124, Rue La Fayette. Starting of a fire at M. Lépine's, an electrician. July 28th, 1890.—Théâtre des Menus Plaisirs. Fire in an artist's box. August 21st, 1890.—Hôtel Central du Bourse de Commerce, 40, Rue du Louvre. Fire in a lobby of the entresol. August 27th, 1890.—Restaurant Maire, 1, Boulevard de Strasbourg. Fire in the electric wires running from the footway to the subbasement of the shop front. August 29th, 1890.—Théâtre de l'Opéra. Fire in the room containing the accumulators furnishing the relief and night lighting, situated on the ground floor looking on the Rue Scribe. September 27th, 1890.—Théâtre des Variétés. Fire in the frame of an electrical resistance. October 1st, 1890.—71, Rue du Faubourg St. Denis, Slight material damage. Gas meter perforated and unsoldered. (Société Anonyme d'Eclairage et de Force par l'Electricité). October 26th, 1890.—Théâtre Français. Fire in tapestry touching incandescent lamps. October 30th, 1890.—5, Boulevard Bonne Nouvelle. Local fusion on the pipe of a gas branch. (Edison Company.) November 1st, 1890.—Grand Café, 14, Boulevard des Capucines. Fire in the basement containing the accumulators and the distribution table. Wainscoting carbonised. (Popp Company.) November 2nd, 1890.—88, Rue Beaubourg. Fire in a shop. November 9th, 1890.—76, Rue Montmartre. Commencement of a fire. (Popp Company.) November 12th, 1890.—99, Boulevard de Magenta. Perforation of a gas pipe. (Société Anonyme d'Eclairage et de Force par l'Electricité.) November 13th, 1890.—Halles Centrales, Pavilion 10. Fusion of electrical conductors. Wainscoting destroyed. December 26th, 1890.—15, Rue de Turbigo. Fire in a shop. December 26th, 1890.—20, Rue de la Verrerie. Rather severe explosion. Three workmen injured. Commencement of a fire. (Popp Company.) December 23rd, 1890.—112 and 118, Rue de Rivoli. Perforation of gas branches. (Popp Company.) January 4th, 1891.—8, Rue Pernelle. Electricity station. (Popp Company.) Fire in a distribution table. January 5th, 1891.—144, Avenue des Champs Elysées. Fire in a resistance frame situated in a cellar (Beau et Cie.). January 7th, 1891.—1, Rue St. Denis (Brasserie Dreher). Slight inflammation of gas and slight damage to pipe. (Municipal network.) March 4th, 1891.—3, Boulevard des Capucines (Café Napolitain). Explosion of gas. (Popp Company.) March 4th, 1891.—5, Boulevard des Capucines. Three explosions of gas. Commencement of fire. (Popp Company.)

If you remember, gentlemen, that to this list communicated by the Prefecture of Police there have to be added five electricity accidents pointed out in the memoir of the Direction of Works, you will thus obtain, for gas lighting and electric lighting, the following table of the accidents which have occurred :—

Year.	Gas lighting.	Electric lighting.
1889 ...	19 ...	2
1890 ...	20 ...	28
1891 (first quarter) memoir ...		7

Should we conclude, gentlemen, from this result, and in particular from the complete list, and consequently the only guide for the year 1890, that the City of Paris should now stop the trial of the electric light in the capital, I cannot sufficiently repeat for my part, and I believe in that I am the interpreter of the majority of the members of the Municipal Assembly, that the examination of the accidents arising in nearly all cases, not from such and such a system of lighting, but rather from an absolute want of supervision and complete negligence in the laying of the canalisation of certain companies, could but unquestionably modify our primitive views in favour of electric lighting. More than ever, gentlemen, we must, in the interest of public safety, take every precaution for putting an end to the present state of things. Already, in the sitting of November 7th, 1890, the secretary to the Prefecture of Police, answering a question of mine on the subject of the explosion which had occurred at the Grand Café, did not hesitate to tell us that the endeavours made by his Administration to obtain the classification of electricity-producing establishments among dangerous establishments, and consequently under the constant supervision of the Prefecture of Police, had not been favourably received. After this declaration, and on the proposition of M. Charles Laurent, the Council voted the following resolution: "The Council, considering to what dangers the extension of electric lighting in the more populous quarters of Paris may give rise to, is of opinion that Parliament, by a special law, should permit the assimilation of that industry to those which are regarded as dangerous and are subject to the incessant supervision of the Prefecture of Police." Later, on the 18th of March last, in

answer to a question of M. Froment-Meurice as to the accident at the Café Larue, in the Rue Royale, the secretary to the Prefecture expressed himself in these terms:—"The decree of July 9th, 1888, has placed the supervision of electrical canalisations in the hands of the engineers of Posts and Telegraphs. They have first of all to examine the plans submitted to them, when a declaration is made in the terms of Article 1 of the decree of 1888. When they have found that the proposal presents every guarantee, they have afterwards to visit the place and assure themselves that the works are well executed according to the conditions. The decree of 1888 established the responsibilities and laid down the supervision; but up till now the organisation of the service and the creation of the supervision staff leave much to be desired. In short, for the region of Paris there is only one official, who personifies in himself the whole service." As you see, gentlemen, the Council has not ceased to protest against the organisation at present in force, and if, up till the middle of the year 1891, we state that the Chamber of Deputies and the Administration of the Prefecture of Police have not yet decided, despite our suggestions and reiterated votes to put an end to a situation so eminently intolerable and dangerous, at least it is our duty to protest against this inaction, and to again insist on the legitimacy and good foundation of our claims. In the face of this hesitation of the Government to arm the Prefecture of Police in the interest of public safety with the right of active supervision, it does not seem to me, gentlemen, that the City of Paris can remain inactive and not seek to obviate, at least as far as lies in its power, a repetition of the accidents which the Administration has pointed out to you. The Director of Works in the sitting of March 18th, 1890, recognised the insufficiency of the supervision. "Electricity (said M. Alphand) progresses day by day; on many points it gives advantageous results. But this industry undergoes incessant changes, and the precautions laid down when the specifications were drawn up, which might have been sufficient then, are no longer so now. A re-arrangement of the specifications is therefore necessary. In the interests of safety you have the right to make this revision. The accidents which have occurred prove that precautions must be taken. It is necessary in the first place to avoid the proximity of gas and electrical canalisations. The engineers are studying the changes to be adopted in this direction. I believe they will necessitate a large staff. My conclusion, gentlemen, is this: There are certain precautions to be taken. We make a study of the subject, and we shall submit to you the question in order to arrive, if necessary, at the change of certain portions of the specification with a view to drawing up the measures necessary to ensure public safety." Three months have elapsed since this formal avowal, and the Administration, which since that time has had fresh accidents to record, has not submitted to us the slightest reform, nor a single one of the modifications which itself in March last thought so useful and urgent to be introduced in the specification. We think, gentlemen, it is for the Municipal Council to emerge from this inertia, and, therefore, I have the honour to submit for your approval the two subjoined resolutions. Maybe our votes will not suffice to lessen immediately, and as much as we should wish, the chances of accidents, still, and without any other idea than that of surrounding the extension of electric lighting with all necessary precautions, we shall have the assurance of having pointed out to the Government and the competent administrations a position of which we no longer mean to assume the responsibility.

The following are the two resolutions referred to by M. Binder: "The Council is of opinion that Parliament, by a special law, should permit the assimilation of the electrical industry to those which are considered as dangerous, and subject to the incessant supervision of the Prefecture of Police" (November 7th, 1890). "The Council, considering that after having recognised, since the month of March, the insufficiency of supervision and want of care introduced in the laying of electrical canalisations, the Administration has not yet submitted any modification of the specification, resolves: Within a fortnight's time, the Administration shall submit for the approbation of the Council the reforms to be introduced into the specification of all the electricity companies and the Gas Company with a view to imposing the measures necessary to ensure public safety."

ELMORE COPPER.

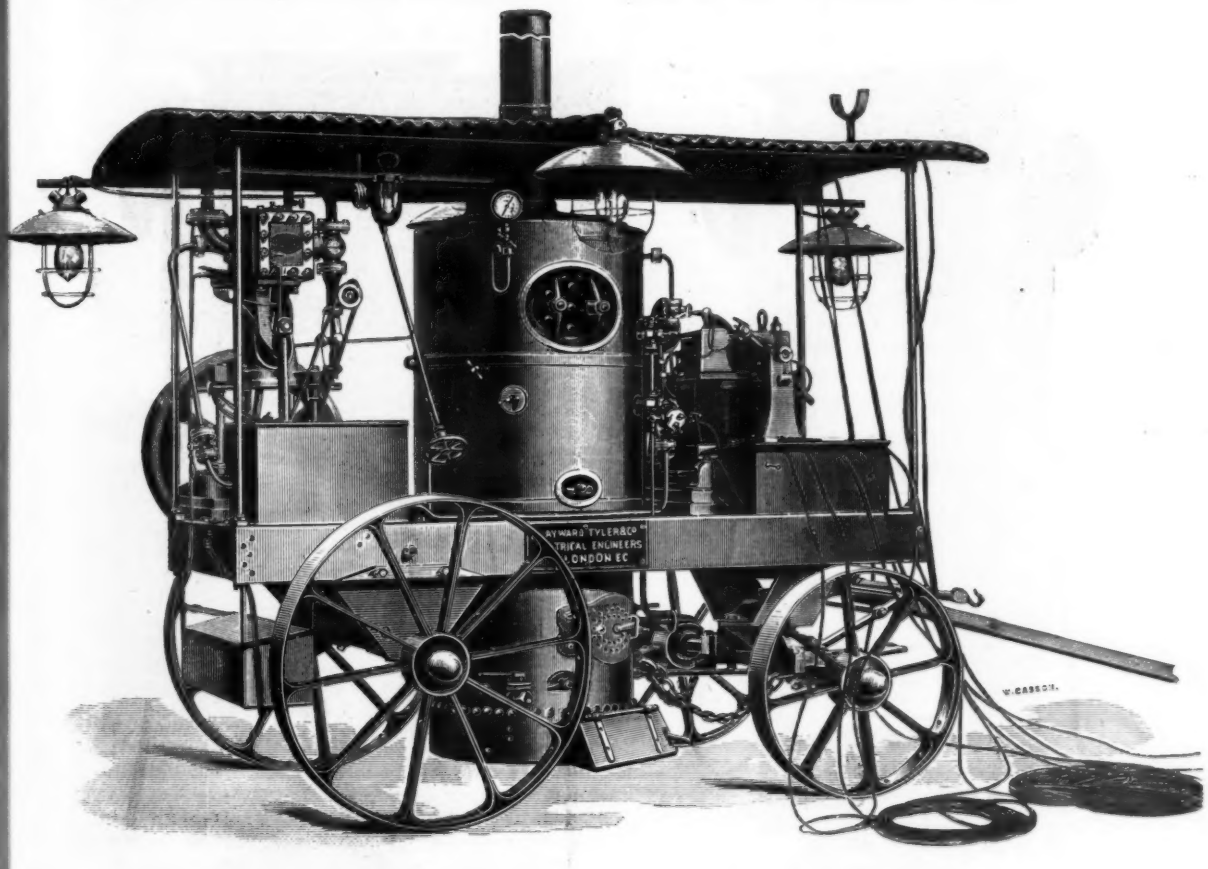
AMONGST industrial companies formed for the working of patents there are, it must be admitted, few prizes and many blanks, and it generally takes much longer to bring such undertakings to a successful issue than the inventors or promoters may have originally contemplated. This has, so far, been the experience of those interested in the various Elmore Copper Companies, but I understand that *much useful work has been done of late*, which promises to bring about almost immediate favourable results. Certain difficulties at the works at Leeds of the Elmore's Patent Copper Depositing Company have been got over, and with next month the output of the company's manufactures *will be increased to* 20 *tons per week*, while *preparations* are being made for putting down plant for a further increase of the output to 45 *tons a week*. What that will mean in the shape of profits to the company I leave you to calculate yourself, the average profit per ton *having been stated to me at* £50 *per ton*. I have satisfied myself, *from the examination of official documents*, that large repeat orders for the company's tubes and other manufactures are being given by important firms, which fact absolutely disposes of certain rumours that had been set about that the products manufactured under the process did not give satisfaction. I shall take the opportunity this week of fully inquiring into the conditions under which the work is being carried on at Leeds, *and I have no doubt that the statements made to me will be fully confirmed*, in which case the £2 shares of the company, now quoted 3½, would appear to be a very *promising* purchase. Even greater progress is likely to be made in the near future by Elmore's French Patent Depositing Company, Limited. This undertaking was started in September, 1890, with a capital of £200,000 in 100,000 shares of £2 each. The bulk of the shares was offered at a premium of 10s. per share, so that the present price of 2⅜-½ does not represent *any advance* on the price of issue. The manufacture under the Elmore process by the French company has from the outset been planned on *a much larger scale*, and it is no secret that M. Eugène Secrétan, of copper ring fame, has thrown himself heart and soul into this enterprise. Whatever his reverses have been, this gentleman still commands a great influence in the French copper trade, and is essentially *the right man in the right place* to push the French Elmore Company's business. The works at Dives, which will be completed very shortly, will have a capacity of 300 to 400 tons a month, and as a similar profit to that estimated for the English company's manufactures is *foreshadowed*, this would mean a gross profit of close upon *cent. per cent.* upon the capital of the company. Our volatile neighbours across the Channel are, I understand, taking a lively interest in the enterprise, and are likely to *operate in the shares on a large scale*. Under the circumstances, therefore, I should say, you could do no harm . . . . in laying in a few hundred French Elmore shares. You will go in under more favourable terms than the original shareholders, as the company has passed through its period of probation, and a big rise may take place at any moment.—*Truth*.

To those of our readers who may not have followed the criticisms on these companies which have appeared in our columns, we would remark that the word at the end of the above extract is not an exclamation of ours intended to confirm the veracity of the statements made and the conclusions drawn, but is merely the name of the paper in which we regret to say the article appeared. It is one of *Truth's* weekly contributions to the service of "Mammon."—(The italics are not in the original.)

English Telephones in Austria.—A Vienna telegram, sent to the *Financial Times*, dated July 25th, states:—"A conference took place at the Public Works Department yesterday, with reference to the granting of a fresh concession to the English Telephone Company, which owns the telephone line connecting Prague with Gratz and Trieste, and the sense of the meeting seemed to be against such renewal. The advisability of recalling the concessions made to other foreign telephone companies was also discussed. The decision of the question was postponed.

PORTABLE ELECTRIC LIGHTING PLANT.

We illustrate a portable electric light plant constructed by Messrs. Hayward Tyler & Co., of Whitecross Street, London, for a large dock company. It is mounted upon a frame carried by four wrought-iron travelling wheels, and is fitted with a pole for two bullocks. The boiler stands in the centre, the engine being at one end and the dynamo at the other. The boiler is 6 feet 6 inches high, by 2 feet 9 inches in diameter; the firebox is crossed by two tubes 8 inches in diameter. The engine has a cylinder 5 inches in diameter by 6 inches stroke, and is of the inverted type, with Pickering governor. By means of a belt it drives the dynamo. It supplies four incandescent lamps of 200 candle-power each. Each lamp is provided with a strong enamelled iron reflector fitted with a wire guard, and a length of twin flexible cable.



THE ABOLITION OF TELEPHONE RENTALS.

The expiry of the Edison patent will, in all probability, mark the commencement of a new era in the development of telephone communication. With the demand for increased efficiency has also come that for a more equitable system of charging for the use of this convenient and expeditious method of intercourse. At present, the same annual rent is required from the subscriber who perhaps only uses his instrument once or twice daily, as from the stockbroker whose daily "calls" often amount to hundreds. Again, the provision made for the great body of the non-subscribing public, in the shape of "call boxes," is, to say the least, neither ample nor easily accessible.

Such a state of things, in which the public convenience is clearly sacrificed to that of the various companies concerned, is certainly not a common-sense one, and our present purpose is to enquire how it may be remedied with increased satisfaction and profit, to both the general public and the telephone companies.

With regard to subscribers, the system of charging according to the number of conversations naturally presents itself, as being perfectly fair in principle, while it does away with a good many superfluous calls, and thus lightens the labour of the exchange attendants. On the other hand, however, it may be urged that the increase of clerical labour, rendered imperative by the necessity of keeping an account for each subscriber, more than balances these advantages. Clearly, then, there is but one way in which the proposed reform can be effected, and that is:—

By the introduction and adoption of a system whereby communication can be obtained from any point of a far-spreading city like London, payment being made at the time each conversation takes place, without the customer being subjected to the formality and inconvenience attendant upon the use of the present "call box."

That the idea of prepayment for each conversation is feasible is proved by the great success which has attended its adoption by the English Government upon the London-Paris telephone line. Another argument in its favour is, that if properly carried out in the manner indicated above, it would completely prevent the frauds to which the telephone companies are at present subject. It is a well-known fact that, although telephone subscribers are prohibited from allowing outsiders to use their instruments, they are so frequently and persistently pestered by their non-subscribing friends for "the use of your telephone for a moment" that they are obliged to give way occasionally, and thus the company is defrauded. The adoption of such a scheme as that propounded above would, it is obvious, put a complete stop to this, supposing the principle of "payment before conversation" to be taken as a *sine quâ non*.

Failure, complete and dire, has been the result of all efforts hitherto made to solve the problem which we are now considering, but very recently an apparatus has been patented by the Actien Gesellschaft, Mix and Genest, of Berlin, which they claim, with some show of reason, to fulfil all the conditions necessary for its complete and effectual solution. A short description of the construction and working of the machine, which is described by its inventors as an "auto-

matic call box," and which is represented in elevation at fig. 1, and opened to show internal arrangements at fig. 2, may be interesting.

Upon a coin being inserted into the slot, S, it first passes through the usual arrangement, P, for testing with regard to diameter, thickness and weight. Should it fail to pass the test it is rejected, but if it proves satisfactory, it passes to a pair of grooves, R, which are movable upon a hinge, X. Here its progress is arrested by the upper of three wheel segments, *r*, *r* 1, *r* 2, which, protruding into the side of the grooves, R, R 1, and actuated by the armature, A, of an electro-magnet, N, form a check arrangement. Just before reaching this point, the coin has pressed a small projecting lever, *i*, thus making contact and allowing bell to be rung when the black knob in front of telephone instrument is pressed. The call is answered in the ordinary way from the central exchange, and if the customer is informed that for any reason the required communication cannot be obtained, he has only to press the white stud, K, when the movable

Zur Benutzung der Fernsprechstelle ist der Einwurf eines 10 Pf-Stückes erforderlich.
Ist die Leitung nicht frei, erhält man die Münze durch Drücken auf den weissen Knopf zurück.
Gesprächsdauer: 5 Minuten
Act.Ges.Mix & Genest, Berlin
D.R.Patent A.
A.v.Boudoux Berlin

FIG. 1.

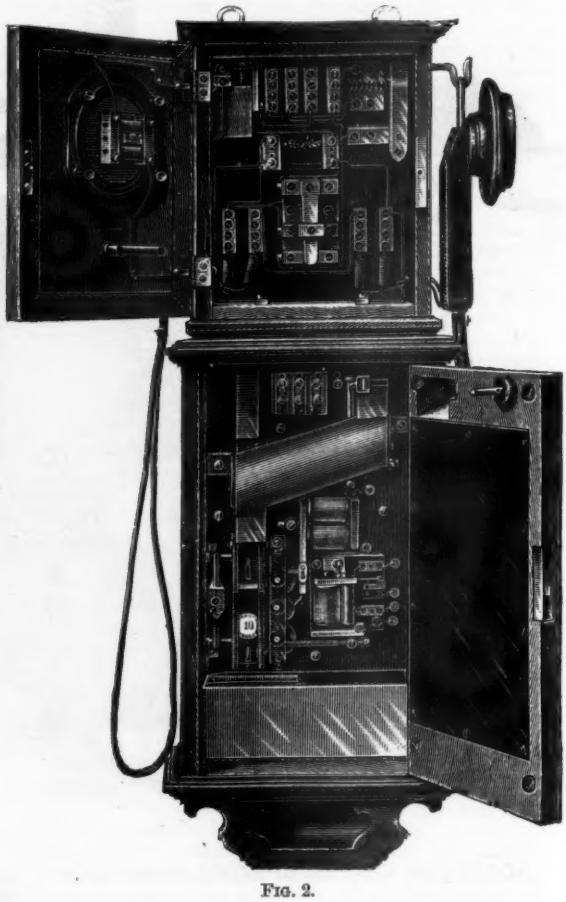


FIG. 2.

grooves, R, are thrown forward, releasing the coin from the check arrangement, and allowing it to fall to the refunding box, Z. Should, however, the desired connection be made at the exchange, the current passes through N, attracting A with a force sufficient to overcome that exerted by the spring, *f*. The coin thereupon falls to the fixed pair of grooves, R 1, and is arrested by segment *r* 2.

Here it remains until the signal at close of conversation is given, when it is again released by the magnet, and allowed to fall into the cash box, C, pressing *en route* a second lever, *i* 1, which, being connected diagonally with *i*, replaces same, and at the same time breaks contact. This lever (*i* 1) is of such a length that a coin passing to the refunding box presses it, replacing it and breaking contact as if at close of a conversation.

Should, however, the closing signal be omitted, it is obvious that the coin will remain in the position shown at fig. 2, viz., in R 1, and resting upon R 2. In order to prevent loss from this cause a lever, connected at one end to the armature, A, and terminated at the other by a small roller, V, projecting into the slot, S, is provided. By this means the armature is moved, as if electrically, upon insertion of the next coin, and the one remaining in the instrument has fallen into the cash box before the other has passed through the testing arrangement.

To sum up the advantages claimed for this instrument :—

1. The exchange can only be rung up upon the insertion of a particular coin, connection being thereupon automatically made for the purpose.

2. The money is refunded if the desired communication is not to be obtained.

3. The line is automatically interrupted upon close of conversation.

4. Absolute security against loss, either on the part of the company or the customer, no tampering or failure being possible.

The apparatus is now being tested by several European Governments and telephone companies, and will be shown in operation, after the expiry of the Edison patent, at the London depôt of Messrs. Mix & Genest, 34, Aldermanbury, E.C.

ELECTROSTATIC INDUCTION.

BY J. E. TAYLOR.

THE main objects of these articles will be, first, to show by direct demonstration in a popular manner that in all cases of electrical transmission of energy, the transmitting medium is the dielectric ; secondly, to place the theory of electrostatics in general on a much clearer footing than it appears to stand on at present, a great deal of unnecessary haze seeming to hang about the subject ; thirdly, to bring forward certain hitherto unrecognised or only half-recognised but important facts in as clear a manner as possible.

In dealing with magnetic fields, we are accustomed to assist the imagination by supposing them to be divided by numbers of lines of force, or better, of tubes of force, and, indeed, without the aid of some such conception (which is essentially a mathematical one) the average mind would be able to form only a very poor idea of what a magnetic field really is. Faraday first used the conception of lines of force, both in magnetic and electrostatic fields, but since his time, the latter seem to have fallen out of general use, and it will be seen from these articles that they are even more serviceable and important in the theory of electrostatics than in magnetism, for in the former case the fields are more complex, and their lines of force must follow more complicated laws.

Let A and B be two conductors, the coatings of a condenser perhaps, between which there exists a difference of potentials. The static field between these two conductors will be approximately as shown by the lines of force in fig. 1, and if A is

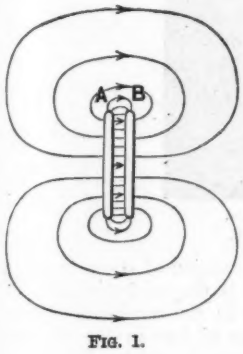


FIG. 1.

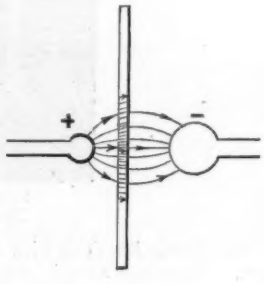


FIG. 2.

positive to B, this fact is demonstrated by arrowheads in the direction shown.

The dielectric in which these conductors are immersed is in a state of static strain, and it is this strain in the dielectric distributed, as shown by the lines of force, that is the sole constituent of all statical phenomena, and to the dielectric as Faraday pointed out, we must go for an explanation. The complete explanation of the mechanism of the strain itself is yet to be learned, but merely from this starting point, viz., that the phenomena of statical electricity are due to a strain in the dielectric an enormously extensive field of research is opened out. It is certainly no new fact to state that the dielectric is strained, but it is just as certainly only a half-recognised fact that in this strain alone lies the full explanation of nearly all statical phenomena.

We know from the experiments of Dr. Lodge on the oscillatory nature of Leyden jar discharges, apart from numerous other proofs, that electrostatic induction is of the nature of a strain. The charging of a conductor, then, simply consists in electrically straining the surrounding dielectric, or in other words, making it one termination of a set of lines of force, or as they will now be called, lines of strain. These lines of strain follow certain clearly defined laws, the most important being as follows :—

1. They extend between *substances* or parts of a substance, their terminations consisting of what are known as the charges on the bodies or in the substance, one of these charges being positive and the other negative, according to the direction of the lines of strain.

2. The number of lines emanating from a body is a measure of its charge, and this number cannot be altered by any variation in the conditions, thus there are as many lines of strain emanating from one plate of a charged condenser when the distance between the plates is a sixteenth of an inch as when it is sixteen feet, unless the charge becomes dissipated by leakage ; and lines of strain (of one sign only) cannot be added to it without increasing the charge by contact or similar process with some other charged body.

3. Unlike lines of magnetic force, the straining force at the ends of a static line is proportional to its length. In a magnetic field the force is the same on lines of short circuit as on long ones.

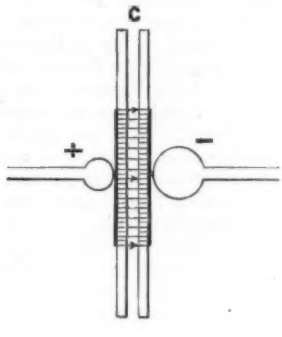
4. They can only exist very temporarily in conductors, the actual time of existence being a measure of the resistance of the conductor.

5. Under certain conditions a conductor appears to possess the power of totally diverting the lines of strain in the dielectric a certain distance around towards itself.

6. A strain being once started between two bodies, that strain remains *between those two bodies* until conditions occur which give the strain an opportunity of expending its energy in heat, light, &c., or in heat alone.

From the first of these laws two important facts may be directly deduced. These are, that there cannot be a charge of one kind isolated by itself, but there must also exist an equal opposite charge, for the lines of strain are between *two* bodies or parts, positive to one and negative to the other ; and also, that all charge is essentially of the nature of a condenser charge. These lines of strain may exist solely in the interior of a dielectric, and in such cases they are produced by a partial break down of the strain in the dielectric. Thus whenever there is a difference of potentials between two parts of a dielectric, as is always the case in air, there may be lines of strain between the two parts terminated in the air itself. These lines of force are very easy to produce in a mixed dielectric where the mechanical strengths of the parts differ much, thus there are charges produced on a plate of even the cleanest and driest glass held between the poles of an influence machine, as in fig. 2, owing to the great strain breaking down in the air but not in the glass, and thus leaving lines of strain in the glass from surface to surface, or in other words, charging the glass plate just as a Leyden jar is charged. If now the plate be removed, and each side partially covered with a loose piece of tinfoil and then the condenser discharged in the ordinary way, the usual Leyden jar spark is observed. A still more striking and conclusive experiment regarding the breakdown of strain is shown in fig. 3, where C is what may be called a compound condenser.

FIG. 3.



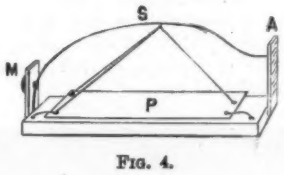


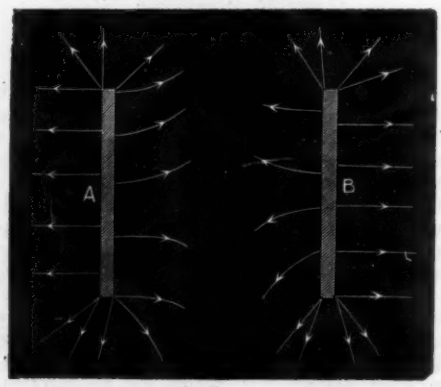
FIG. 4.

It consists of two glass plates with an air space between, each having a tinfoil coating on its outer side (or the experiment may be conducted on the same lines as the previous one, and the tinfoil coatings dispensed with while charging). On placing this arrangement between the poles of the machine and looking between the plates, the breakdown of the strain in the inner air space in the shape of numerous spark and brush discharges is very plainly seen. If the plates are at all damp only a faint glow-discharge, invisible in daylight, takes place. These experiments, more particularly the former, show as clearly as anything could be shown, that the action is confined to the dielectric. This partial breakdown of strain is also easily produced in a uniform dielectric, as will be shown when dealing with points and their action. This hitherto half-recognised action (breakdown of strain) is of the first order of importance in the theory of vacuum discharges, and in many other ways.

With regard to the second of these laws.—Lines of strain when mapped out on paper in the section of a static field, represent areas of equal total strain, their primary use being to show the distribution of the strain. The number of lines

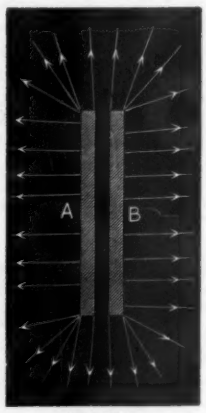
multiplied by the strain in any one area therefore represents the total charge on one of the bodies from which the lines emanate. Or better, if the *solid* field were divided by columns of strain, the total charge is represented by the product of the number of columns and the strain in any one. Now, theoretically speaking, a current of one ampère flowing for one second into an insulated body would impart to that body a charge of one coulomb under any conditions. Therefore the charge on one coating of a condenser is constant so long as it is perfectly insulated, whatever the distance between the coatings may be. Therefore, again, the number of columns of strain emanating from a body is constant, and can only be increased or diminished by contact or similar process producing a current.

With regard to the third law it is well known that when the coatings of a condenser are separated the potential difference between them rises, and if the distances between them are very small in proportion to the capacity, it rises just in proportion to the distance between them, this being another way of saying that the capacity of a condenser is inversely proportional to the thickness of the dielectric. According to the second law the number of lines of strain emanating from one coating is the same when separated, but the potential is proportionally increased. Potential is, perhaps, best defined as *tendency for giving up lines of strain*, for it is the "power of doing work" which is, practically speaking, measured by this tendency to give up lines of strain. The energy spent in separating the coatings is thus made to increase the potential energy of the strain in just the same proportion as the lines are lengthened. It may now be seen that the length of any one column of strain divided by the average sectional area (which quotient is the same for all columns emanating from one particular body), is a measure of the potential of the body. The interesting result of this law is that under suitable conditions the attraction between the plates of a charged condenser *increases* on *separation* or *falls* on approach, a fact which so far as the writer is aware has not been brought prominently forward before. A rough piece of apparatus used for demonstrating this fact is shown in fig. 4. P is a thin metal plate suspended by silk threads from the steel spring, S, which is adjusted by a micrometer screw at M. The baseboard is covered with tinfoil to serve as the attracting plate and the position of P is read on the scale, A, by means of a paper index arm fastened to the spring, S. The apparatus must, however, be made fairly large to observe the effect successfully, as it is not suited for observing very small variations. The theory of this is as follows: The force $F = n^2 l$, where n is the number of lines of strain between the two plates, and l the length of these lines, that is the distance between the plates. Now n is determined by the ratio of the capacity of the dielectric between the plates to that between P and other outside earth-connected objects, consequently so long as this ratio is great l increases more rapidly than n^2 diminishes, but increasing l increases the rate of leakage, so that great care must be taken in the insulation of P.



Apart.
FIG. 5.

Another point bearing on this law is that if two bodies charged similarly be brought nearer together their potentials rise, or fall if taken away. The complete explanation of this requires a rather complicated mathematical analysis which it is not proposed to enter into here, but a rough and ready explanation may be taken from figs. 5 and 6, which show two discs first apart and then together. When apart their fields interfere very little with one another, but when brought together are jammed up, and thus increase the tendency for giving up lines of strain. The mathematical analysis referred to is entirely dependent upon the distribution of the lines of strain, but the increase, on approach, of the potentials is not equal to the increase of surface density, which it will be noticed is doubled, or thereabouts.

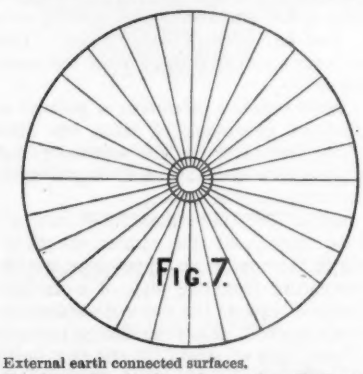


Together.
FIG. 6.

The fourth law deals with formation of strain in conductors. Whenever a static strain is projected through a conductor, that part of the strain in the conductor collapses, evolving its energy in the shape of heat in the conductor. Consider a high capacity condenser charged to a low potential difference and then connected so as to discharge through a resistance. A current is formed through the resistance, and the whole of the energy evolved as heat in that resistance. The actual nature of this discharge will, however, be deferred until the subject of the transfer of energy is dealt with.

The fifth law refers to the screening action of gauze covers on electroscopes, &c. Perhaps the simplest way of showing this effect clearly is to suspend a couple of pith balls by silk threads inside a gauze net, and however strong the field in which it may be placed, there is not the slightest effect on the pith balls. For the same reason, a small aperture in a hollow conductor leaves the interior still unaffected by any outside disturbances. This law has a not unimportant bearing on the distribution of the charge on conductors of various shapes, as will be seen when that subject is treated.

The sixth law means that when a strain is once started between two bodies, the lines of strain joining the two, however subdivided they may be by intervening conductors, yet considering such conductors as merely affording a short circuit for the lines, remain so, joining them until disconnected by

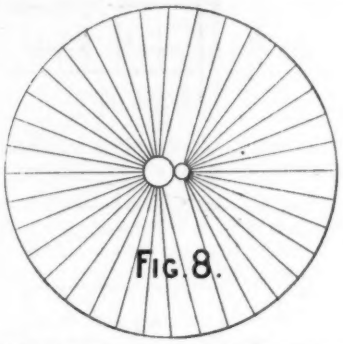


External earth connected surfaces.
Showing surface density on large and small spheres.

such a breakdown or collapse of the strain as shall transfer their terminations to other points, or until a collapse along the whole length of the line occurs. This may be regarded simply as a deduction from law No. 2.

The action of points in discharging bodies also admits of easy explanation after having thoroughly grasped the principle of columns of strain. Fig. 7 shows in the clearest manner the relation or rather non-relation of surface density

to potential. The potential of the smaller sphere is equal to the length of the columns of strain divided by the average sectional area, which quotient is almost identical for both spheres, and for a practical case they may be considered identical, whilst the surface density is much greater on the smaller sphere. For all cases of steady strain, the lines must of course be normal to the surfaces, and as a deduction from fig. 7, the following method may be used for *approximately* determining the distribution on conducting bodies of various shapes :—On the outside circle (representing the other terminations of the lines of strain) mark off equal parts, and from the points of division draw straight lines (except in cases of re-entrant surfaces) normal to the surfaces of the bodies. This gives us an idea of distribution, and completely explains the discharging effect of points, for the strain is so concentrated just at their ends that the lines collapse along a

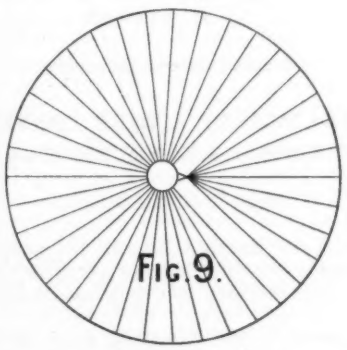


Distribution on large and small spheres in contact

short length outwards. The distribution on any body can only be accurately determined when its position and conditions are known, as such distribution varies with its position.

Besides this obvious reason for the above method being only approximate, it will be seen at a glance that where the lines concentrate at one end they should correspondingly diverge at the other, or we would have a difference of potentials between parts of the conductors. Again, according to law No. 5, when the lines come near another part of the surface they will be diverted to that surface.

With regard to the discharging effect of points, we have here the case of a partial breakdown of strain in a uniform dielectric. The lines collapse along a short length outwards from the point leaving their termination at some point in the



Action of points.

air itself, which thus electrified and free to move, acts in obedience to the strain, beyond doubt causing the wind from an electrified point. We are accustomed to see many out-of-the-way explanations of the action of the so-called electric whirl ; but to put it in few words, the real explanation of its action is the overbalancing of the strain on the side remote from the point, in the same way as two similarly electrified bodies move away from one another on account of the overbalancing strain on their remote sides. It is in no case necessary to assume an actual force of repulsion, and it is, perhaps, better to assume it non-existent.

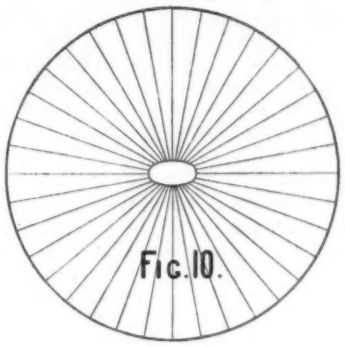
There is another hitherto unrecognised fact with regard to partial breakdown of strain, in that such partial breakdown has a great deal to do with residual charge in condensers. Residual charge, it may be mentioned, is, at least in part, due to three simple causes, which are :—

1. The breakdown of strain in weak parts of the dielectric, such as air bubbles in the glass of a jar.

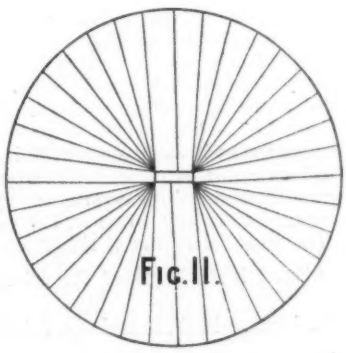
2. Imperfect contact between the tinfoil and glass surfaces, or the presence of such intervening substance as does not readily allow of either the formation or collapse of static strain (*i.e.*, semi-conductors.)

3. Diffusion from the edges of the coatings over the surface of the glass.

All three are doubtless different modes of manifestation of the same thing, viz., transference of the ends of the lines of strain from one position to another, through various resistances. Considered separately, the first effect is remarkably well shown by the compound condenser of fig. 3. It will be remembered that on charging this condenser the breakdown



of strain in the inner air space could be seen. Now, on discharging this condenser exactly the same phenomenon is observed, due to the maintenance of the whole difference of potentials between the two inner surfaces on completing the external circuit. If the plates be adjusted fairly close together an abnormal number of subsidiary discharges may be obtained, due to the whole of this back discharge not taking place at once, which again is very probably due to that effect taking place *at the surface* of the glass, which is generally supposed to account for residual charge, called by Mr. Heaviside "intrinsic electrisation" and crudely illustrated by Dr. Lodge as the slipping back of the molecular strain. Such effect probably only takes place at the surfaces, because with more surfaces, as say three glass



plates in the dielectric, the residual charge is generally increased, and also because the molecular condition of the glass surface is somewhat different to the interior molecular construction, combined with the fact that residual charge is not exhibited by air condensers, which latter have a perfectly uniform dielectric.

The second cause is demonstrated by charging a glass plate, as in fig. 2, and then placing loose pieces of foil on its surfaces. On connecting these pieces of foil we get a first discharge, and also a large number of subsidiary discharges, or if the external circuit be maintained, a continuous crackling is heard for some time, caused by minute sparks from the glass surfaces to the coatings. A short time ago this effect caused unlooked for trouble in connection with a system

of electrical transmission of energy, in which glass condensers charged by high tension alternating currents were used. The imperfect contact was rendered obvious by the heating which occurred at the surfaces of the glass. The reason for this heating was pointed out by Sir William Thomson, who suggested condensers with mercury coatings to secure more perfect contact.

The third cause of residual charge may be demonstrated by breathing into an ordinary Leyden jar, which of course increases the diffusion from the edges of the coatings with a corresponding increase of subsidiary discharges and decrease of the efficiency of the jar. This experiment succeeds best when the atmosphere is not too dry. Flat condensers having more edge than jars, their residual charge is, as a rule, greater. Another way of showing this effect is to make a flat condenser with movable coatings, and after having discharged it thoroughly, to displace the coatings a little when a portion of the diffused charge returns as a residual.

To show the simplification of theory by utilising the conception of lines of strain, it may be as well to consider one or two simple cases. Thus to show that the force between two electrified bodies is inversely proportional to the specific inductive capacity of the dielectric in which they are immersed, all the demonstration required is

$$F = n^2 l;$$

and n being constant

$$F = l;$$

and since increasing specific inductive capacity of a dielectric is equivalent to decreasing the thickness

$$l = \frac{1}{\text{Spec. induc. capacity}}$$

F being the force exerted, n the number of lines of strain between the bodies, and l the length or average length of these lines.

This case, it may be mentioned, is quite analagous to the increase of attraction on separation of the coatings of a condenser.

Again, with regard to the attracted disc electrometer for a given difference of potentials,

$$F = n^2, \quad n = \frac{V}{d}, \quad F = \frac{V^2}{d^2}$$

where V is the difference of potentials and d the distance between the discs, or if the method of keeping F constant be adopted,

$$F = \frac{V^2}{d^2}, \quad V^2 = F d^2 \quad \therefore V \propto d.$$

In measuring or comparing the capacities of insulated bodies under fixed conditions, it must be remembered in all cases that the capacity of the measuring instrument and even of the leading wires cannot be neglected, and the calculations must be made accordingly.

The transfer of energy.—Let A and B be two wires, and imagine at one end a single column of strain between them. This strain will not, of course, remain so packed up at one end, but will expand itself along A and B, filling the whole intervening dielectric. In so doing it will expend energy in the same way as a compressed gas expends energy in expanding. The amount of energy so expended can easily be calculated. The potential energy of the strain in the first position is $\frac{l}{a}$ where l is the length of the column and a its average sectional area. In the second case it is also $\frac{l}{a'}$ but a' is very much greater than a, and the energy expended in expanding is the difference between the potential energy in the two cases, for in the case of *steady* strain, the whole of the energy is potential. The equivalent of the energy expended appears as heat in the conductors A and B. Next consider the effect of adding at the other ends of A and B, a connecting wire, as in fig. 13. Whilst the strain is expanding, the conditions are as represented in the figure. As the strain reaches the limit of the *circuit*, it is completely neutralised in a manner that may more readily be seen from fig. 14. The strain as it travels along is collapsing upon the conductor, and, indeed, it is only by thus collapsing that it is enabled to travel at all, for the terminations of the lines of strain are fixed to the points between which they are originally set up unless disconnected by collapse starting from those points. The energy which expends itself as heat in the conductor at any particular point is thus transmitted through the dielectric. The initial strain may be produced by inserting a charged condenser, in which case, if the resistance of the circuit be high enough and the capacity of the condenser also high enough and charged to a sufficiently low difference of potentials, there is a uni-directional current produced in the circuit until the whole of the strain is neutralised. Or if the capacity of this condenser be infinite, not only is the current

FIG. 12.

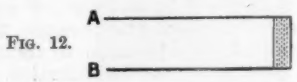


FIG. 13.

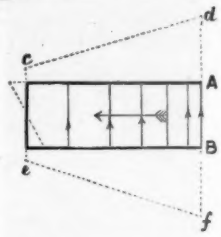


FIG. 14.

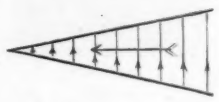
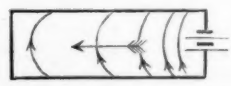


FIG. 15.



uni-directional, but steady and continuous. Or, again, if we have some means of maintaining the initial strain, the current is steady and continuous. Now, a battery is an apparatus for maintaining an initial strain, and thus the above theory applies to all steady currents. It is seen that there is a continual formation of static strain in the circuit, and a formation of static strain is a "displacement current" which produces magnetisation of the medium whilst it lasts, and in just the same manner the continual formation of strain produces continual magnetisation. A little thought will show that the spreading or expanding of the strain will give the explanation of dynamic currents in all the various shapes and conditions of circuits, and the correct method of depicting a circuit in which a current is flowing, is by lines of static strain as in fig. 15.

(*To be continued.*)

THE VIBRATION OF A WIRE TRAVERSED BY A CONTINUOUS ELECTRIC CURRENT.

BY M. D. HURMUZESCU.

A FINE metal wire stretched between two supports, one of which is provided with a strainer or spring for regulating the tension, on being traversed by a *continuous* current begins to vibrate.

The amplitude of the vibrations, which is at first very small, increases as the time goes on, and quickly arrives at a maximum, which it maintains as long as the current is passing through, provided that the surrounding atmosphere remains in the same condition, or, at any rate does not undergo any sudden change. The vibrations may thus continue indefinitely; they stop in a few seconds when the current is interrupted.

For a given tension, the amplitude of the vibrations seems to depend (according to the experiments which I have made up to the present) on the difference in the temperature of the wire and of the surrounding atmosphere. Now, as it is the intensity of the current which produces this difference of temperature in a given wire, the amplitude should vary according to the intensity.

The explanation of this fact seems to me to lie in the interchange of heat between the wire and the surrounding

atmosphere ; this constitutes really a *thermic motor*, in which the energy expended is supplied by the current, and the principle of the conservation of energy can be applied to it.

Any cause producing a change, in any manner whatever, in the mode in which this interchange of heat takes place will modify the phenomenon in some way or other. We can foresee that the finer the wire the more rapid will the vibrations be ; this is confirmed by experiment. I repeated the experiment with wires of different natures, and found that the phenomena always preserves the same character. If we put the wire in a large glass tube the movement is regular, because the wire is sheltered from the movements of the air. On closing the two ends of the tube, I observed no change in the rapidity of the vibrations. I hope soon to bring before you the law of this phenomenon from the points of view of the tension of the wire, the difference of temperature between the wire and the surrounding atmosphere, and the manner in which the interchange of heat between the two sources is effected.*

NOTES.

Electric Tramway at Breslau.—A project for an electric tram at Breslau is being drawn up by Messrs. Höffer and Vondersinn.

An Electric Tram for Parcel Carrying.—We learn from a foreign contemporary that the Electric Tramway Company of South St. Louis, U.S., have now put a car on the road which is used only for transporting baskets, boxes, parcels, &c., from the city to the suburbs. This electric parcel delivery tramcar is proving very useful.

The Compagnie Générale des Téléphones and the State: Decision of the Council of State.—Last week we gave some details as to the litigation between the above telephone company and the French Government, and now the Council of State has given its decision, of which the following is a *résumé* :—The Council of State is of opinion that the agreement of July 22nd, 1886, on the violation of which the company based its claims for damages, and which had for its object the concession, for a period of 25 years, of the working of the urban telephone network and the establishment and working of all the lines to be installed during the same period in France and Algeria, could only become valid by virtue of legislative approval. In default of this approval, which was refused, the company could not complain of the non-execution of the agreement, the more so as it brought forward no fact which might have fixed the State's responsibility in other ways. It resulted, therefore, from the invalidity of the 1886 agreement, that the Compagnie des Téléphones was always bound by the permits which had been conferred on it in 1884, and according to which the State could make the purchase at any time against an indemnity. The appeals of the Telephone Company against the decisions by which the Minister of Commerce had committed agents for taking possession of the material of the undertaking, and against the decisions of the Council of the Prefecture rejecting its pretensions to an indemnity, founded on the violation of the 1886 agreement, are, therefore, rejected. Still, in limiting the omission of the experts to the appreciation of the technical material properly speaking, the Council of the Prefecture had excluded the taking of objects which, while not of a strictly technical character, might be necessary to the working. The Council was of opinion that, in order that the rights of the parties might be effectively reserved, it was necessary to alter the decision given on this point. Consequently, it was decided that the experts nominated in pursuance of the decision of the Council of the Prefecture of the Seine should draw up an inventory and make an estimate of all the plant which, according to the respective pretensions of the parties, might be considered as forming part of the material entering into the terms of the specification. The judicial authorities would have eventually, if necessary, to decide as to the value of these pretensions. No mention whatever is made as to the question of costs.

* These researches were made at the Laboratory for Physical Research at the Sorbonne.

Electrocution.—A Belgian contemporary is the authority for asserting that several English members of parliament propose to introduce in the next session, a Bill to authorise the adoption of electrocution.

The Electric Light at Kingswood.—The tender of Messrs. Parfitt, of Keynsham, has been accepted for lighting the Kingswood Local Board district with the electric light. They have already made a successful installation at Keynsham.

Electric Light in Berlin.—The electric light in Berlin is, according to the *Electrotechnische Zeitschrift*, coming more and more to the front. At the end of the year 1890, 4,944 arc lamps and 80,788 incandescent lamps were in use, as against 3,778 arc and 62,876 incandescent lamps in 1889, being an increase for the year 1890 of 1,166 and 17,912 respectively.

State Acquisition of Telephones in Austria.—The latest news is to the effect that the Austrian Minister of Commerce has just decided that the concession formerly granted to English capitalists for the working of the Prague-Gratz-Trieste telephone line will not be renewed. The Government intends, a Vienna telegram states, to take over all the telephone lines conceded to foreign companies.

The Electric Light at Southampton.—At a meeting of the Pier and Harbour Board last week, specifications and forms of tender for electric lighting on the Royal Pier, and for two electric cranes on the quay were submitted, and the committee recommended the board to advertise for tenders to carry out the works. It was reported that the electric light company were prepared to lessen the period for the terms of agreement to five years. They also waived a clause requiring notice to be given them of any additional power or lights required, and they further undertook to lay the main to the entrance gates of the Royal Pier. It was stated that for about £500 the whole of the pier could be lighted. The recommendations of the committee were adopted and a member expressed a hope that before long, on the quay as well as on the pier, gas would be superseded by the electric light.

The Electric Light on the ss. "Scot."—The twin screw steamer *Scot*, which is now on her first voyage to the Cape, having on board General Booth, and which is by far the largest and most powerful that has yet been constructed for the South African Mail service, has a splendid installation of the electric light, which shows off the proportions of the lofty and handsome grand saloon to great advantage. The installation is by Messrs. W. Denny & Bros., and consists of 710 lights. There are three of Messrs. Brown Bros. dynamos, and the whole of the cabins and passages on the main deck are ventilated by their electric fans. For the ventilation of the passenger accommodation on the main deck, six electric fans of large capacity are supplied. These exhaust the air from the passages and cabins, and efficient downcasts are provided to supply fresh air. Messrs. Denny have also fitted the electric bells. The directors of the Union Steamship Company are to be congratulated upon the excellence and completeness of the electric light arrangements on board their fine steamer.

The Electric Light at Bournemouth.—At a meeting of the Bournemouth Town Council last week, the lighting committee reported that the surveyor had prepared a report as to the lighting of the pier and pleasure grounds with electricity in connection with the sea water scheme, and they recommended that the opinion of an electrical engineer should be obtained before proceeding further. This recommendation was adopted. The roads committee reported the receipt of letters from the Brush Electrical Engineering Company, asking for the consent of the council to underground mains being laid in certain roads within the borough, and that they had directed the clerk to request the company to submit plans of their proposal drawn to a proper scale in accordance with their provisional order, and to request that where the mains crossed roads, they should do so in straight lines with an inspection box at every angle. In the discussion which ensued, it was generally admitted that the production of the electric light at a cheap rate would be very beneficial to the town. Eventually, the report was referred back to the committee for further consideration.

The Commercial Cable Company.—It is claimed that with their perfection of modern duplex appliances and improved modes of automatic transmission, the Commercial Cables can do more accurate work in a given time than any other.

Stoke-on-Trent Lighting.—The gas committee have recommended the town council to take steps to promote a bill in Parliament, enabling the corporation to erect new gas works, and to supply electrical energy for any public or private purposes as defined by electric lighting acts.

Electric Light at Exeter.—The Exeter Electric Light Company, has intimated that the directors regretted they could not see their way to send in a lower estimate than was supplied by them in 1888, and reminding the council that their tender at that time was considerably below any other.

Electric Lighting at West Ham.—The West Ham Town Council are about to borrow £25,000 for a public hall and municipal offices, which are to be lighted by electricity. Another £20,000 will be borrowed for recreation grounds for the southern portion of the borough.

Cardiff Electric Lighting.—The provisional order for electric lighting in Cardiff having become law, the subject has been referred to the lighting committee. Mr. W. Massey has acted for the Corporation for about a year and helped them with the order, and now with his assistance a small committee has been instructed to examine and report upon what had been done in other towns.

The Goldsmiths' Technical School.—Mr. W. Slingo, A.I.E.E., Principal of the Telegraphists' Central School of Science, has been appointed lecturer in the electrical section at the Goldsmiths Company's Technical and Recreative Institute, which has just been opened at New Cross. Mr. H. Ashton, who was formerly with the Brush Electric Light Company, has been appointed an assistant instructor in the engineering section. Students desirous of instruction in the theoretical branches of electric science have to pay a fee of 7s. 6d. per session, which sum also represents the fee of those joining the class for practical laboratory and workshop tuition, whilst telegraphy and magnetism will involve a further expenditure of 5s. each, and a further sum of 7s. is charged for the privileges of membership of the Institute. The building will be lighted with the electric light.

Sevenoaks Lighting.—At a meeting of the Sevenoaks Local Board on Monday, July 27th, a letter was received from the secretary of the Electric Trust Limited, referring to the extension of time for executing works under the Sevenoaks electric lighting provisional order obtained by them last year, and stating that they had applied to the Board of Trade for an extension of the order for twelve months, on the ground that they were in communication with the clerk and surveyor to the Local Board. The Clerk (Mr. H. J. Thompson) said that the latter part of the letter was not strictly correct, as no communication had been received from the Trust, who under their order were bound to commence the work within twelve months, but had not done so. Ultimately it was decided to await a communication from the Board of Trade before passing any resolution.

Maidstone Lighting.—At a meeting of the Maidstone Local Board on Tuesday, the Sub-committee on Electric Lighting reported a long conference with the manager of the Electric Installation Company, when they ascertained that if the Local Board obtain a provisional order they will experience great difficulty in getting any electric company to take a transfer thereof; that the cost of the smallest installation would be £3 a light for 5,000 lights, and that if the company carried out the lighting of Maidstone the board would have the power to purchase the undertaking at any time at a sum yielding 5 per cent. on the outlay. The committee viewed the company's works at Chelsea, which were no doubt as good as any existing at the present time. Councillor Barker urged the appointment of a committee to discuss the question of working the electric lighting themselves or not. It was then resolved to appoint a committee to report further on the matter.

Telephones in Germany.—Telephone communication was established on the 1st inst. between Stuttgart, Ulm, Augsburg and Munich.

The Manchester Ship Canal.—Messrs. Browett, Lindley and Company, engineers, Salford, the well-known makers of steam engines for electric lighting purposes, are about to erect works at Barton, adjacent to the Manchester Ship Canal.

Rechniewski Dynamo.—Messrs. E. L. Berry, Harrison and Co., of Lyric Chambers, Whitcomb Street, W.C., have been appointed sole agents for the Rechniewski Machine which obtained the only gold medal for dynamos at the Paris International Exhibition, 1889.

Private Telephony on a Large Scale.—A contemporary states that the new system of telephones being fitted at the Thomson-Houston factories at Lynn, Mass., is almost completed. The number of telephones used will be from 50 to 75, and each having private wire, while 19,000 feet of twin wire will be used.

Obituary.—We regret to announce the death of Mr. W. R. Morris, inspector of telegraphs at Cardiff, which took place at his residence on Thursday afternoon of last week. He had had a life-long connection with the electric telegraph, and had had an exceedingly intimate knowledge of telegraphic and electrical matters, and was looked upon as one of the ablest men in the service.

The Dublin Chamber of Commerce.—At a meeting of the council of the Chamber of Commerce it was agreed that resolutions be placed on the programme for the meeting respecting the desirability of having all lighthouses and coastguard stations of the kingdom in telegraphic or telephonic communication with each other through the General Post Office Telegraph system of the country.

National Electric Light Association at Montreal.—It seems that the forthcoming convention to be held either next month or early in September, will be a very important event. Extensive preparations are being made to give the guests a warm welcome. An electrical exhibition of a grand nature is to be given during the convention. The Americans are anticipating a large attendance of electrical men, and the whole affair promises to be a great help to this particular line of industry.

Monkey Island Electrified.—The annual dinner and excursion of the staff of the General Electric Company, Limited, favoured by glorious weather, took place on Saturday last. About 90 members of the firm and several invited guests went by train to Windsor, where two comfortable steam launches were in readiness to take the party to Monkey Island, where the day was spent in various sports and recreations. Many valuable prizes were given away to the winners in the athletic contests.

An Aluminium Steamboat.—A correspondent of the *Standard*, writing from Lake Zürich, states that some novel and interesting experiments have recently been made on the Lake of Zürich with a steamboat built entirely of aluminium, which claims to be the first of its kind. The boat weighs only about half a ton—viz., about half the weight of an ordinary boat of the same size. It was built at the works of Messrs. Escher Wyss & Co., of Zürich, the metal having been furnished by the Aluminium Works of Schaffhausen, where it is obtained by an electrical process, the dynamos being driven, not by steam engines, but by turbines, which utilise the water-power of the celebrated falls of the Rhine, so that the boat claims to be exclusively the product of Swiss labour and power. It carries eight persons, and, with a petroleum engine of only two horse-power, easily makes six miles an hour. Aluminium not being subject to rust, the permanent colour of the boat is a beautiful dull white, whilst the chimney, being of polished aluminium, shines like silver. The trial trips of the boat were eminently successful, and it is anticipated that the construction of aluminium steamers, having the same capacity, and only half the weight of the iron ones now used on Swiss lakes, has a great future before it.

Electric Lighting for Sutton.—The Sutton Local Board has resolved that the question of electric lighting for Sutton be considered by the whole board acting in committee.

Alteration of Address.—Mr. A. F. Spooner has removed his Patents Designs and Trade Marks Agency office to 124, Chancery Lane.

Tramway Traction.—The North London Tramways from Finsbury Park to Wood Green and Edmonton will be worked by horse cars instead of steam ones from to-morrow. The process of evolution will only be complete when electrical energy supplants the quadruped.

Electric Lighting at Huddersfield.—At the last meeting of the Huddersfield Town Council, it was resolved, on the recommendation of the Gas Committee, to accept an amended tender submitted by the Brush Electrical Engineering Company, Limited, for carrying out an installation of electric lighting in the town at a cost of £20,640.

Electric Light in Yarmouth.—The new premises of Messrs. Diver and Son, wine merchants, Yarmouth, have been electrically lighted by Whitmore and Binyon, of Wickham Market. The whole of the work seems to have been well carried out, and it is to be hoped that other enterprising firms in this popular seaside resort will emulate the example set.

Hauling by Electricity.—A system of hauling coal by electricity was inaugurated on the 24th inst. with considerable ceremony in the Abercanaid Colliery at Merthyr, owned by Hill's Plymouth Company. The machinery, which is of a very elaborate description, was set in motion by Mr. Hankey, M.P., and the first operations have afforded complete satisfaction. Horse labour in the mines has thus been superseded.

The Edison Lamp Decision.—The New York *Electrical Engineer* thinks that the sustaining of the Edison patent in the States is a matter for general congratulation. It admits that probably the defendants will demur, but declares that Judge Wallace's decisions have the reputation of being appeal proof. If this is so, we can only hope that the Edisom Company will adopt a wise and judicial policy, and permit the incandescent lamp business to be carried on under easy and equitable conditions.

Telephone Cables.—In regard to the application of the National Telephone Company to place a portion of their telephone cables beneath the public ways, the Streets Committee of the Commission of Sewers recommended that it was inexpedient to give consent to the application of the company to use the subsoil of the City until the contracts lately entered into for electric lighting purposes had been carried out.

Lighting at Sturford Mead.—Mr. A. A. Campbell Swinton has just completed the entire reorganisation of the electric lighting of Sturford Mead, near Warminster, for Theodore Cookson, Esq. The new plant comprises a 6 nominal H.P. engine and an 8 nominal H.P. boiler, capable of developing 12 brake H.P., an 8 kilowatt dynamo and a 50-light battery of accumulators, also the re-wiring of the house, stables, &c., throughout. A feature of the installation is the electric lighting of all the farm buildings and cow-sheds, it being somewhat of a novelty for cattle to be treated to this new illumination.

Royal Humane Society.—The committee of the Royal Humane Society have conferred the medal for saving life on Mr. Cavendish Boyle, colonial secretary, Gibraltar, and Mr. Robert Greey, commander of the Telegraph Company's steamship, *Amber*, for "by presence of mind, and good organisation and arrangements at the time, being the means of saving a number of lives on the occasion of the wreck of the *Utopia*."

New Cable between Denmark and France.—The laying of the Great Northern Telegraph Company's new cable between Denmark and France, that is, from the Island of Fanoë, on the West Coast of Jutland, to Calais, was successfully completed on Wednesday last. Its length is 370 miles.

Correction.—In our description of the Atkinson-Elliott magnetic separator last week, the block of the connections was printed upside down.

Electrical Engineer for Glasgow.—The Glasgow Corporation Electric Lighting Committee are taking in applications this week for the post of electrical engineer to the Corporation. Applicants have been expressly forbidden to canvass any member of the Corporation.

Admiralty Contract for Asbestos Goods.—The excellent quality of the manufactures of the United Asbestos Company, Limited, has for the seventh time secured for that company the contract for the supply of all kinds of asbestos goods required for use in Her Majesty's Navy during the ensuing twelve months.

Personal.—Mr. J. F. Albright, managing director of Crompton & Co., Limited, has just returned after a very successful tour round the world. He started originally with the Iron and Steel Institute for the United States, and then went to Australia to look after the business of the Crompton Electric Supply Company of Australia. After spending some months in various parts of Australia he went to Ceylon, and from thence to Calcutta. After this he proceeded to Colombo and Mauritius, *en route* for Durban. Making this his headquarters, he went up country to Pretoria, where his company is about to carry out the lighting of the town. We are glad to learn that the change has done him much good, and we feel sure that his genial presence once more amongst us will be warmly welcomed.

Mr. C. J. Robertson, who, in 1887, installed and has since then superintended the glow lamp factory of J. Boudewijnse, Middelburg, Holland, has severed his connection therewith, and is now partner in, and managing director of, the firm Latzko and Scharf, glow lamp manufacturers, Vienna.

The Fatal Accident on the Electric Railway.—The gentleman to whose untimely end we allude on p. 130, was identified as T. Allen Partridge, a retired captain in the merchant service, and the inquest was held on Monday afternoon by Mr. G. P. Wyatt, deputy coroner for East Surrey. The substance of the evidence given by three of the passengers who were in the lift at the time, was that just as the lift was set in motion, and whilst the inner lattice gate was only partly closed, and the outer gate open, the deceased ran up from the inclined passage to the front of the lift; he pushed aside the porter, who was then in the act of closing the gates, stumbled against the edge of the lift, and seizing hold of the inner gate, was carried upwards and killed in the manner mentioned. Without calling in the lift attendant, the room was cleared, and after about a quarter of an hour's deliberation, the jury returned a verdict of "accidentally decapitated." The jury recommended that before the lifts were set in motion, both gates should in future be closed. This recommendation the company's solicitor said should receive attention.

A New Firm.—Messrs. Newington and Priddle have recently started in business at Berry Street, Clerkenwell, as electrical and mechanical engineers. Mr. Newington was in pre-electric lighting days one of the pupils of the late Robert Sabine and Sir Charles Wheatstone, and was afterwards connected with the Pilsen Company. He acted for several years as engineer to the Jablochkoff Company, and still more recently has been carrying out several large contracts on his own account. His partner has had very large experience in the construction and manufacture of all kinds of electrical and mechanical apparatus, and, as works manager, the control of workmen, and, from nearly 20 years' intimate knowledge of both gentlemen, we know they will deserve, and we hope they will achieve, success. From a recent inspection of their compact workshop and machinery we imagine that the firm is in readiness to undertake anything with which they may be entrusted.

Aberdeen Electric Lighting.—Just as we go to press we are informed that the proposed scheme of electric lighting for Aberdeen promises to be revived.

Telephones in Vienna.—There are now no less than 4,400 subscribers in the telephone central station in Friedrichstrasse, Vienna.

NEW COMPANIES REGISTERED.

George W. Pridmore and Company, Limited.—Capital, £1,000 in £5 shares. Objects: To adopt and carry into effect a registered agreement dated the 18th May, 1891, made between G. W. Pridmore, of 110, Holyhead Road, Handsworth, of the one part, and W. Everden of Suffolk House, Cannon Street, E.C. (as trustee for the company) of the other part; to purchase, exercise, and develop patents or inventions for use in the manufacture of lamps, or for apparatus capable of being used in the manufacture, purification, consumption, supply or distribution of gas or electricity; and to carry on the business of lamp manufacturers, and manufacturers of all apparatus connected with the use, supply or distribution of gas or electricity whether for light, heat, motive power, or otherwise. Signatories (with one share each) A. E. Pridmore, 2, Broad Street Buildings, E.C.; R. J. Stamp, 130, Evering Road, Stoke Newington; J. Brookes, 6, Great James Street, Bedford Row, W.C.; W. Everden, Suffolk House, E.C.; W. P. C. Everden, Suffolk House, E.C.; T. Woolcock, The Hales, Tottenham; R. Annan, 9, Liverpool Street, E.C. The number of directors is not to be less than two nor more than four, the first being A. E. Pridmore, G. W. Pridmore, and R. J. Stamp. Qualification, £30. Remuneration as determined at the general meeting. Registered on the 21st inst. by H. H. Richardson, 2, Broad Street Buildings, E.C. Office, Suffolk House, 5, Laurence Pountney Hill, Cannon Street, E.C.

Tayler Smith's Electric Company, Limited.—Capital £6,000 divided into 300 6 per cent. preference and 300 ordinary shares of 10 each. Objects: To purchase or otherwise acquire the business and goodwill of Mr. Thomas Tayler Smith, electrical engineer, of 4, Circus Place, London, E.C.; and to carry on the business of electrical engineers, contractors for electric lighting and other works connected with the use of electricity and manufacturers of and dealers in electrical plant, fittings and apparatus. Signatories (each of whom takes one preference share): The Earl of Shrewsbury and Talbot, Ingeston, Stafford; M. P. Bouverie, 11, Little Stanhope Street, Mayfair; K. Stephenson, 34, Beaufort Gardens, S.W.; C. H. Hall, 54, Grandison Road, Clapham Junction; G. Ashdown, 56, Gresham Street, E.C.; W. H. Young, 10, Winchester Avenue, Brondesbury, N.W.; F. W. Darch, 3, The Gardens, East Dulwich. The business of the company is to be conducted by managers, the first being T. T. Smith and K. Stephenson. Registered on the 21st inst. by Cave & Co., 4, Fenchurch Street, E.C. Office, 53, South Molton Street, Oxford Street, W.

Morecambe Electric Light and Power Company, Limited.—Capital, £15,000, divided into 14,950 ordinary and 50 founders' shares of £1 each. Objects: To acquire the rights of T. R. Andrews and T. Preece, the undertakers of the Morecambe Electric Light and Power Order, 1890, of and in the undertaking authorised by that order; in order to become the undertakers of that order, to carry into effect an agreement dated June 27th, 1891, made between T. R. Andrews and T. Preece of the one part, and J. Jowett, on behalf of the company, of the other part; and to carry on the business of electricians, mechanical and electrical engineers, manufacturers of and workers and dealers in electricity, electric motive power, and electric light for all public and private purposes. Signatories (with one share each): J. Jowett, 18, The Crescent, Morecambe; W. B. Hodgson, 10, The Crescent, Morecambe; C. F. Mabbott, 4, Market Street, Morecambe; H. F. Hartman, Swan Arcade, Bradford; G. F. Snowdon, Loveliview, Morecambe; W. E. Farrar, 9, Regent Road, Morecambe; W. Morgan, Scarborough. Registered on the 27th inst by J. Tilly, Lancaster, without special articles. Office: 18, The Crescent, Morecambe.

Home Telephone Company, Limited.—Capital, £500 in £5 shares. Objects: To acquire letters patent for the use, sale and manufacture of any telephone, telegraph, electric light and electric power apparatus, or any other invention, instrument or apparatus connected with the utilisation of electricity; to contract for the carrying on of any telephonic, telegraphic, electric light or power or any other business; and to establish and conduct any system of telephonic or telegraphic communications, or for the transmission, storage, utilisation, or application of electricity. Signatories (with 1 share each); A. C. Bond, 222, Strand, W.C.; W. B. Banham, 11, Hanover Street, Pimlico; W. Smith, 9, Providence Terrace, Earl's Court, S.W.; H. de Witte, 19, Marguretta Terrace, Oakley Street, Chelsea; E. A. Horne, Harvey Terrace, Leytonstone; E. A. Branbach, 24, Cromhurst Road, S.W. The regulations of Table A mainly apply. Registered on the 27th inst. by H. P. Spottiswoode, 32, Craven Street, Charing Cross; office, 85, Queen Victoria Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Blockley Electric Lighting and Manufacturing Company, Limited.—The annual return of this company made up to the 13th ult, was filed on the 20th ult. The nominal capital is £20,000 in £5 shares. 508 shares have been taken, upon all of which the full amount has been called and paid. Office, Blockley, Worcester.

Electric and General Investment Company, Limited.—The first annual return of this company, made up to the 1st inst., was filed on the 11th inst. The nominal capital is £200,000 divided into 39,900 ordinary and 100 founders of £5 each. 20,000 ordinary and the 100 founders' shares are taken up, and upon the ordinary shares of £1 per share has been called, while upon the founders shares the full amount has been called. All calls have been paid, amounting to £20,500. Office, 1 and 2, Great Winchester Street, E.C.

House-to-House Electric Light Supply Company, Limited.—The annual return of this company, made up to the 3rd inst, were filed on the 11th inst. The nominal capital is £350,000, divided into 100 founders', 57,900 ordinary, and 12,000 preference shares of £5 each. 100 founders', 8,322 ordinary, and 342 preference shares have been taken up, upon all of which the full amount has been called. The amount considered as paid on the founders' and 1,000 of the ordinary shares is £5,500. The calls paid amount to £38,278, and unpaid, to £42. Office: 117, Bishopsgate Street, Within, E.C.

LEGAL.

Oriental Telephone Company Limited.—Mr. COZENS HARDY appeared to support a petition under the Memorandum of Association Act, requesting confirmation of a special resolution. The company was started for the purpose of carrying out every form of enterprise connected with telephones. They kept a large electrical staff, and being embarrassed, they wished to use that staff in electrical enterprises beyond mere telephony. They had no power to do this without the alteration they requested, and they were unable to hold shares acquired by them in other companies which were not limited to telephonic communication.

Mr. JUSTICE ROMER showed that the alterations wanted were most extensive, and the company would be enabled to carry on any electrical business, even lighting houses and lighthouses.

Mr. COZENS HARDY, Q.C., stated that this was so, but the present limitation damaged the company very seriously.

Mr. JUSTICE ROMER said the title must be altered, and he would make the order to go when the matter was again brought before him, provided it were altered in the form of "Oriental Telephone and Electrical Company Limited."

Mr. COZENS HARDY stated that they would have to make application to the Board of Trade for the alteration in title.

Mr. JUSTICE ROMER gave them liberty to mention the matter either to the Vacation Judge, or to himself after the vacation.

CITY NOTES.

Manchester Edison-Swan Company, Limited.

AT the ninth ordinary general meeting of the Manchester Edison-Swan Company, Limited, held on Wednesday at Manchester, the following report was presented:—

"The net profit, including last year's balance, amounts to £2,292 10s. which it is proposed to appropriate as follows:—

"To payment of dividend at 5 per cent. per annum	£1,000	0	0
"To payment on account of 5 per cent. cumulative preferential dividend on the "A" shares at the rate of 1¼ per cent. on £40,000 (the original paid up capital of the company), for the year ending May 31st, 1883	500	0	0
Balance to be carried forward ...	792	0	0
	£2,292	10	0

"If the above be approved, the dividend warrants will be issued on August 1st, 1891. Since the last general meeting the directors have had to deplore the loss, by death, of their esteemed colleague, Mr. Edward Cross. The directors have filled this vacancy on the board by the election of Mr. Frederick B. Ross, as a director of the company. Mr. W. P. James Fawcus, the company's manager, has been elected to fill the vacancy on the board caused by the resignation, through ill-health, of Mr. J. R. Williamson, and the shareholders are asked to confirm his appointment as director. Mr. Frederick B. Ross retires in accordance with the company's articles of association; he is, however, eligible, and offers himself for re-election."

Mr. V. K. ARMITAGE, chairman of the directors, presided.

The CHAIRMAN moved the adoption of the report and statement of accounts, and explained that the dividend of 1¼ per cent. on the £40,000 was on the original capital, which was entitled to 5 per cent. accumulative dividend before any money out of the profit was paid on the "B" shares to the parent company, and now for the first time they were able to go back to the year 1883 and pay something on account of the £40,000. The amount it was proposed to pay was £500, and that came to the 1¼ per cent. Their former managing director, Mr. Williamson, had been obliged to go to Australia for his health, and with a view of establishing him in business there a number of the directors had joined together and formed a small company with a nominal capital of £5,000 and called up £2,500. That business had prospered beyond their expectations, and in order to further it the directors thought it advisable to utilise some of the money of the Edison Company lying in the bank. The business was rapidly extending and was already regarded as the principal one of its kind in Australia. In regard to the price of the Edison-Swan shares in the market, he had been repeatedly asked how it was they were so low. All he could tell them was that the number of shares that changed hands was infinitesimal, and if it were not for one gentleman there would scarcely be any changes at all. No doubt one reason why the shares went up and down was that there was a very heavy liability on them—a liability of £8 for every £2 called up—and when, as occasionally happened from time to time, one of their shareholders who owned a lot of shares died, his executors very naturally at once realised, regardless practically of the intrinsic value of the shares.

Mr. I. C. WATERHOUSE seconded the adoption of the report.

Mr. CHARLES AGNEW and Mr. BECKER criticised the action of the directors in investing in the Williamson Company without consulting with the shareholders, but, after further explanations by the CHAIRMAN the report was adopted, together with the recommendations as to dividend, &c.

Globe Telegraph and Trust Company, Limited.

THE eighteenth ordinary general meeting of the above company was held on Tuesday at Winchester House, Old Broad Street, Sir John Pender, K.C.M.G., presiding.

The secretary, Mr. Willian Payton, having read the notice convening the meeting, and the minutes of the last general meeting, the annual report, which appeared in last week's ELECTRICAL REVIEW, was taken as read.

The CHAIRMAN, in proposing the adoption of the report, said: Gentlemen, as usual, before I ask you to approve of the resolution for the adoption of the report, I will make a statement giving you some idea of the working of the company during the last 12 months. During the existence of the company the dividend on the ordinary shares has been progressive. It has never fallen below 2⅜ per cent., in 1887, and that was the time of the fierce Atlantic competition. Since that date it has been augmented to 3½ per cent. in 1888; to 4⅜ in 1889; to 5 in 1890; and I am pleased to say that—although it is not a large addition—still it is an addition, and we propose to-day to declare a dividend of 5¼ per cent., showing, as I have said a gradual and steady increase. The average dividend paid since the commencement of the company in 1874 is £4 7s. 1d. per cent. on the ordinary shares, and £6 per cent. on the preference shares, and these, taken in conjunction, give a uniform dividend throughout our working period of 18 years, of £5 3s. 6d. per cent, which would seem to show that the investment is a steady, progressive and good one. The company's holding in the Eastern Telegraph Company of close upon a million of stock is a very good investment indeed. They give us on our investment price £6 7s. 2d. per cent. The Eastern Extension, in which again we have a very large holding—something like £560,000—gives us £6 16s. 5d. per cent., which you will observe is also a very good investment. These two items in our accounts give us a stamina which enables us to keep up our ordinary dividend and to slowly increase it. The Anglo-American Company, in which we hold over a million—£1,117,354—yields us only £3 4s. per cent., and the Direct, in which we hold £198,900, gives us a return of £6 2s. 11d. You will therefore see gentlemen, that the Anglo is the weak element at the present moment; but I think there is a possibility of improving that investment, and probably by the time I have the pleasure of meeting you again next year—if God spares me for another year—I think we may be able to show you an improvement in that respect. At all events we never cease thinking as to the best means to adopt to increase the value of your property and increase your dividend. All the other securities, with the exception of some minor investments, enable us to maintain our dividend. The Brazilian Submarine Company's shares cost us par, and pay us on the quarter of a million of stock which we hold therein, at the rate of £8 10s. per cent., so that you see we have some very good things, and if we have some things which are not quite so good as they might be, we have some very good things which qualify those which are not quite so good. The report is full and explicit and requires little explanation. With regard to the money we received from the German Government, a re-investment of it has been made in 1,850 shares in the Western Union Telegraph Company, and 2,050 shares in the American Cable Company. We have always endeavoured to give something of an international character to our investments, and as I have had an opportunity of seeing something of the American system of telegraphy—more particularly that of the Western Union—I am quite satisfied that their property is a most valuable one, and that the cables which they have now in hand—which it would probably have been better had they left alone and stuck to their land system—are good ones. They guarantee the property that we have in their submarine cables, and they guarantee us 5 per cent. on our investment, and my impression is that there is not a better guarantee or a safer investment to be found anywhere. In regard to their own property it covers an enormous area, and it is altogether a prosperous and successful company, and must continue to be, because telegraphy is one of those introductions into what we may call more modern life and civilisation which cannot go back—it must go forward. There is a craving for it, a demand for it, and as the world grows so will the interests of telegraphy grow. In connection with this investment of the money repaid by the German Government, I may tell you that the par value of money in Berlin is subject to an exchange, and to bring that money to England we lost something like £1,100, but by the advice of our auditors we have debited that amount to the cost of our new investments. If we take the statement of shares held by the company shown on page 6 of the report, and take the cost at the lowest market prices and then get the highest market prices and therefrom strike an average, we shall find a mean rise in the value of our stocks. Now I want to draw your particular attention to this, we have a large interest in the Eastern Extension and the Brazilian—but taking the whole of our stocks together we show a profit upon them at the present time of something like £343,715. There can be nothing more satisfactory than that, in my opinion, and it enables us, therefore, to go on steadily increasing our dividend. As you know, we have no reserve fund, we give you all we get, and the success of the other companies is, of course, very important to us. Therefore we are large shareholders in all these companies, and we naturally keep ourselves in touch with them, so that we are a strength to them if they are strong and good in their management. We make them weak if we find they are not managed as they should be. Therefore you can well understand that the Globe has a considerable control over the companies now in existence; but I am pleased to say we have never required to interfere in any case. The companies are well managed and successful; and the companies in which we are so largely interested pay us good dividends, with the exception of the Anglo-American and the Direct Spanish, which pay us rather a low dividend; but still, as I said, I think it is possible to improve this, and I hope when I see you again that I shall be able to draw attention to the subject. We should have had a full board sitting here to-day had Mr. Ford been present. Mr. Ford is one of our early colleagues, and he has always shown a deep interest in the company, but, unfortunately for him, he has passed through the terrible scourge of the influenza, and, somehow or another, it is clinging to him in such a way as to prevent his being able to be present to-day. I express my regret personally, and I am sure you will all join with me in sympathising with Mr. Ford in his illness. Now I have referred to the Western Union and I need not speak of it again, but with regard to the Globe I would like to show how successful it has been in averaging dividends. If a man held Anglo shares separately, he would be receiving to-day £3 per cent. instead of receiving £5 5s. per cent., which you are receiving now from the Globe. I think, therefore, gentlemen, you will admit that you are benefitted by letting the Globe average dividends for you instead of averaging them yourselves. We meet only once a year, and even then it is very difficult to make up a speech beyond giving you the simple facts. We prefer to confine ourselves to facts rather than introduce sentiment, which we might do, but this I must say, that while I would like to see a larger gathering of our constituents at these annual meetings—because we have 8,000 shareholders in this company—you must admit that the confidence of the large body of them in the directors must be very great indeed when they are represented to-day by such a small number. But while I would like to see a larger number of shareholders present, I think it is a satisfaction to know that the shareholders trust us, and when a company is prosperous it does not require much talking from the chairman; but when a company is in trouble or difficulties you know the chairman has a good deal to do to try and make black appear white, and white black. Now, we have nothing of that kind in this company—our business is to tell you exactly how the concern is going on, so that you may feel when you retire from this meeting that the investment you have made is one which is in good hands, and that the chances are rather above the average of your receiving your dividends regularly, and probably getting them increased in the future. I have now to move: "That the report and accounts for the year ending July 18th, 1891, submitted to this meeting be and they are hereby received and adopted, and that a dividend be now declared, payable on and after this day, of 3s. per share on the preference shares, free of income tax, and 4s. 6d. per share on the ordinary shares, income tax having already been deducted, making with previous payments a total dividend for the year of 6 per

cent. on the preference shares, less income tax, and 5¼ per cent. net on the ordinary shares."

The MARQUIS OF TWEEDDALE seconded the resolution, and the report was adopted without discussion.

The CHAIRMAN then proposed the re-election of the Marquis of Tweeddale as a director of the Company.

Sir JAMES ANDERSON seconded the motion, which was carried, and the Marquis of Tweeddale thanked the meeting for the confidence shown in him by his re-election.

The CHAIRMAN next proposed, Sir HENRY GOOCH, Bart., seconded, and it was resolved that "Mr. James Pender be and is hereby re-elected a director of this company."

Mr. PENDER, having thanked the meeting for his re-election,

Mr. BURT proposed the re-election of the auditors, Mr. J. G. Griffiths, F.C.A., and Mr. William Griffith, B.A., at a remuneration of 30 guineas each. He said it was very important that in a concern of that kind the accounts and books should be very carefully audited. They had been well looked after in the past by the auditors, and he believed they would be in the future.

Mr. J. KING seconded the motion, which was carried.

Mr. GRIFFITHS, in returning thanks, said he could speak most confidently as to the excellent way in which the books were kept, and also he could speak as to the securities. He had found everything in good order, and he thought they had good ground for hope that the company would produce good fruit in the future. So far as he was concerned he would do his best to deserve the renewed confidence they had reposed in him. Before sitting down he would like to propose a motion which he believed would meet with a unanimous reception, and it was a vote of thanks to their able chairman, Sir John Pender. He need say little in support of such a resolution, for all present had been witnesses of his urbanity, his courtesy, and his ability. He (Mr. Griffiths) thought they might take it as a strong recommendation in favour of the management that so few shareholders had come to the meeting to-day. The public reputation of Sir John Pender was certainly very great; it was not confined to England, but extended over Greece, Portugal, Spain, and other countries. He had already received some honours, which he trusted would culminate in a peerage, for few persons had done so much for the benefit of commerce and the world in general as those who had brought before the public the discovery of telegraphy. Business itself would be at a standstill, and it would not be able to spread itself as it had done if it had not been for telegraphy, and commerce generally was indebted to Sir J. Pender for the extension of the system of telegraphy as well as for its improvement. If it had not been for the heroic efforts which he made in connection with the Anglo-American cable, the cable would never have been laid from England to America, and not only was the commerce of the country indebted to him for that, but even those greater extensions to the East—to Australasia and elsewhere—were undoubtedly the work of his master hand. He was not saying that to flatter Sir John, but it was a subject of congratulation to them as shareholders, that a gentleman who stood so well with the public generally, and whose character was calculated to improve the position which their stock held in the market, should be at the head of their affairs. With the vote he begged to couple the names of the other directors.

Mr. KING seconded the motion which was carried unanimously.

The CHAIRMAN returned thanks on behalf of himself and colleagues and said it was very pleasant to hear Mr. Griffiths speak as he had done of them all. It was pleasant because he knew thoroughly the root and the growth of this telegraph trust. Only the other day Mr. Griffiths was down in the strong room of the company examining their securities, and he fancied the securities left a very good impression upon Mr. Griffiths' mind, because he was a shareholder as well as one of the auditors. Mr. Griffiths could say some very hard things if necessary and also very pleasant things, and he on behalf of the board accepted with thanks the kind things Mr. Griffiths had said about them. He again thanked the meeting on behalf of himself and colleagues for the renewed confidence reposed in them, and said that so long as the shareholders entrusted them with their affairs they would exercise their judgment in making the interests of the shareholders the first consideration.

The proceedings then terminated.

Crompton and Company, Limited.

THE third annual general meeting of the members of the above company was held on Wednesday at the Cannon Street Hotel, under the presidency of Mr. R. E. B. Crompton.

Mr. F. R. REEVES (the secretary) having read the notice convening the meeting, the annual report (which appeared in the ELECTRICAL REVIEW last week) was taken as read.

The CHAIRMAN then said: Gentleman, I have now to move "that the report of the directors and the audited statement of accounts for the year ending March 31st, 1891, be and the same are hereby approved and adopted." With respect to the statement of accounts, I think the shareholders will agree with me that the balance of net profit, amounting to slightly over £13,000, shows a very satisfactory rate of increase upon the balance of the previous year, and justifies the remarks which I made at last year's meeting as to the probable steady increase of the company's business. During the current year we have executed several important contracts, and our out-turn has very largely increased; but as I explained last year, these large contracts were taken on fixed rates of profit, and therefore these profits, although sure ones, are necessarily not large ones. At the same time these contracts constitute a very sound and satisfactory feature of the business, and a feature which we hope to see extended during the course of the current year. Among the important orders we have now in hand is one for the lighting of the city of Pretoria, which is the capital of the Transvaal, and in connection with this order, my co-managing director, Mr. Albright, has recently visited South Africa, and will himself explain to you that there is every probability of our having there laid the foundations of a large business. With regard to the other contracts, negotiations are in progress for very good central station contracts on the continent, any one or more of which may be decided shortly, and any one of which would result in a large addition to our turn over. We have also negotiations in hand for central stations in several large towns in England, but it is not advisable for me to mention the names of any of them here. We think we stand a fair chance of obtaining a fair proportion of these orders, and if these were taken on the same basis as those I have already referred to, viz., on a fixed percentage of profits on the actual outlay, they will produce a sound and fairly remunerative profit for our shareholders. It is necessary that a firm like ours, which has always occupied a leading place among electric lighting firms, should keep abreast of all modern improvements; in fact, we have ourselves to be introducers of such improvements. Amongst such improvements, I may say that during last year we have perfected the subject of electric railways, and have succeeded in carrying out for the Southend Local Board an exceedingly successful example of the modern electric railway, which has received the highest encomiums from everyone connected with it, and of which Dr. John Hopkinson, the consulting engineer to the Local Board, said that he never passed the final certificates of any work with so much pleasure, and leaving so little to be desired. Another cognate branch of the business which we have developed during the year has been electric underground haulage for mines. We have recently carried out two very large sets of such haulage, and with complete success. The last case was one in South Wales, which was successfully started last Friday, close to Merthyr-Tydvil. In connection with this, I may say that a colliery manager who witnessed the experiments informed me that we could book enough orders to fill our works from this source alone. These last contracts for haulage, however, do not appear in the accounts that are now before you, but they will come into the accounts for the current year. I may mention, in connection with this question of electric haulage, that a very great deal is due to the exertions of our South Wales agent, Mr. J. C. Howell. You will observe in the report that we have expended a very considerable sum on capital account, partly in increasing our buildings at Chelmsford, and fitting them up with proper fittings and tools, and partly in fitting up our leasehold works that we have opened in London at Lillie Road. These works have already been of very great assistance to us, and have enabled us to increase our output in such a way that had it not been for these works we should not have been able to carry out the large London contracts which have formed such a satisfactory feature of the present year's income. Coming to the statement of accounts, I would refer to the question of debentures. At the last meeting I informed you that we had decided to issue our second £25,000, out of the total of £50,000 of debentures, and we have offered them to the shareholders. The result was not quite so satisfactory as we expected it would have been. At the date of this present report only £31,000 had been subscribed—namely, a little over £6,000 since last year's meeting. At the present moment we have still £15,000 worth of these debentures remaining to be placed. The directors have not in any way pushed the issue of these debentures by advertisements or otherwise, but we now find it really necessary that the company should have this additional capital, and the directors will be glad if any of the shareholders will send in their applications, so as to close the list. These debentures, as you are aware, are amply secured, and as the total annual interest on the issue is only £2,500, and the net profits of the company are no less than £13,000, there can be little doubt that the debenture holders will receive their money regularly in the future, as they have done in the past. As exemplifying the advantage to this company of having plenty of working capital at command, I may mention that during last year we were able, by careful management and prompt payment of accounts to our creditors, to secure for the company an additional profit by cash discounts of a sum in excess of the total amount required for the year's interest on the whole of the debentures issued. With regard to the net profits, you will see that the directors state in the report that, after providing for the debenture interest and other payments, and, putting aside £500 for doubtful debts, they propose to declare a dividend at the rate of 3s. 6d. per share, equivalent to 7 per cent. on the preference and 5s. 6d. per share, making, with the previous interim dividend, 8 per cent. per annum upon the ordinary shares. I may say that the good feeling which I said in my speech last year has existed between ourselves and our staff of workpeople still continues to exist, and I have, on behalf of myself and the other directors, to thank our staff for the very satisfactory way in which they have worked during the past year, and I have to thank the works managers for the immense pains and trouble they have taken in promoting the working of the men's sick, recreation, and other clubs, and for the very cordial feeling which, in consequence, exists between all the *employés* of this company and the staff. I shall have great pleasure in answering any question any shareholders present may choose to put to me on any matters arising out of the report, and I will now conclude by moving the resolution.

Mr. C. F. TUFNELL seconded the motion, which was carried *nem. con.*

The dividends as recommended by the directors having been approved,

The CHAIRMAN said he had to inform the shareholders that since the last meeting they had lost a very valuable director in the person of Sir Charles Grant. Sir Charles's marriage and other reasons caused him to leave London and reside in the country, and he gave up his directorate in that company in common with several others, and he wrote him (Mr. Crompton) a letter stating with what regret he left the board. To fill that vacancy the directors had appointed Mr. H. H. J. W. Drummond, who had already served some considerable time on the board, where his services had been of the greatest assistance to the company. Quite recently they had secured the services of

another extremely valuable director—of Viscount Emlyn, who was deputy chairman of the Great Western Railway, and was an extremely well-known and hard-working official—in fact, he was probably one of the hardest working railway officials in all England. He considered that the acquisition of Viscount Emlyn and Mr. Drummond to the board very greatly strengthened them. Mr. Drummond was a very hard worker, and Viscount Emlyn's great experience and great knowledge of the management of large bodies of men and his general large railway connection, could not fail to be of the very greatest assistance in furthering the interests of the company; in fact, he thought he was justified in saying that it would very greatly increase their influence in the West of England. He therefore proposed that the appointment of those two gentlemen as directors be confirmed.

Mr. G. S. ALBRIGHT seconded, and the motion was carried.

The CHAIRMAN, in proposing the re-election of Mr. B. Gibson as a director, said that Mr. Gibson was one of the first directors of the company, and had given much valuable assistance and hard work to the concern ever since its formation, and the company could ill do without that gentleman.

Mr. R. PAYNE seconded the proposition, which was agreed to.

Mr. GIBSON said he was much obliged to the shareholders for the renewed confidence they had shown in him by re-electing him to a seat on the board—and a pleasanter board to serve on he did not think existed anywhere. The board always acted harmoniously together, and they were very fortunate to have such servants as they had at the works and in the London offices. From the highest to the lowest all the servants of the company did their work honestly and well, and he believed that anything like "scamping" was unknown in the company's business.

Mr. J. F. ALBRIGHT then gave the meeting a short account of his trip round the world, which he said was a somewhat extended one, undertaken in the interests of the company. He had not had time to think out any elaborate statement as to his travels, but he would give them briefly his general impressions from what he had seen. He first visited Canada, where he met the agents whom they had recently appointed, and he had every reason to be satisfied with those gentlemen, and he believed that since his visit the orders that they had sent home had been of considerable importance. He also visited the United States, but, as the shareholders were probably aware, owing to the extremely high tariff it was almost impossible for them to do any business there, although they were doing a certain amount. After that he went to Australia and saw the company which had been established there. He saw the managing and other directors, and his impression of the company, from the way in which it was being worked was, that although there were—as there were in all new companies—many things to be improved—at the same time, it appeared to him that they were in the position of being better represented in Australia than any other English or European firm. In Australia the business was considerable, but it could only be done by people who knew the country well, and who were well known in the country, and one reason why he thought they were so well represented there was because the people were old-established residents in the country. The competition there was so keen, that it was almost impossible to do business unless one was known in the country. From Australia he went to India, where he stayed only a very short time indeed, but going on the same lines as elsewhere, he arranged for the company to be represented there by a very old established house in Calcutta—in fact, by the oldest house—which had done more electric lighting in India than any other house. From India he went to the Mauritius, and he found that even in a small island like Mauritius, almost all the work necessary had been done, and there was practically nothing to do, and if there were, there was no money to pay for it. He then went on to Natal, and after going to the city of Durban he went over to Pretoria, where he made the final arrangements for the contract for lighting that town. He thought that the fact of their having obtained the contract for lighting Pretoria was likely to be the means of establishing for them a very considerable and, he hoped, a very valuable business throughout South Africa. He had also made arrangements for their representation in the Transvaal, independent of that particular contract, and he was asked to report to the Town Council of Durban, and he also met some of the representatives of the Town Council of Cape Town, and in both those places he thought there was fair prospect of work being obtained. Altogether, from his trip round the world, he thought it would have a very satisfactory result from a business point of view.

Messrs. J. H. Duncan & Co. (the auditors) having been re-elected,

Mr. PAYNE said he would like to offer mutual congratulations to the directors and the shareholders upon the satisfactory balance sheet presented to them, and he could not help saying how pleased he was to find that the whole system of governing the company was in harmony with the desires of the proprietors, as where harmony existed success must necessarily be attendant. He begged, therefore, to propose a vote of thanks to the chairman and directors, to whose efficient working the profitable results of the past year were due.

Mr. GRIMSHAW seconded the motion, which was carried by acclamation.

The CHAIRMAN, in response, said that, on behalf of himself and colleagues, he had to thank the shareholders very heartily for the kind way in which they had recognised their services. Of course it was their duty to serve the shareholders, and he did not think they had done anything more than their duty, which was a line of policy he hoped they would always adhere to in the future. He thought the prospects before them were good, but a commercial undertaking like theirs was, of course, subject to the fluctuations of trade and money—they being particularly affected by the fluctuations in the money market, which controlled the supply of new capital for such undertakings as electric lighting companies. So much depended upon that, that it was impossible for him to prophesy as to the future, and he could not go beyond the present order book, which was well filled. He had every reason to hope they would have another satisfactory year, and that they would be able to come before the shareholders at the next meeting with equally satisfactory results as on the present occasion.

The proceedings then terminated.

Anglo-American Telegraph Company, Limited.

THE following is the directors' report to the ordinary half-yearly general meeting of the proprietors, to be held in the Great Hall, Winchester House, 50, Old Broad Street, in the City of London, to-day.

The total receipts from January 1st to June 30th, 1891, including the estimated balance of £844 7s. 3d. brought forward from the last account, are estimated at £139,184 16s. 3d. This amount, however, is subject to revision, as the law-suit between this company and the Paris and New York Telegraph Company, is still pending.

The traffic receipts show a decrease of £8,432, as compared with the corresponding period of last year, caused in a large measure by depression of trade.

The total expenses of the half-year, including the repair of cables, &c., as shown by the revenue account, amount to £54,657 11s. 5d.

One quarterly interim dividend of 12s. per cent. on the ordinary stock, and of £1 4s. per cent. on the preferred stock, was paid on May 1st 1891, absorbing £42,000, and a second quarterly dividend at the same rates, will be paid on August 1st, 1891, leaving a balance of £527 4s. 10d. to be carried forward to the next account.

The company s repairing ss. *Minia*, has been engaged during the past half-year in the repair of the 1873 cable, off the coast of Ireland, and of one of the cables connecting Heart's Content with Placentia, Newfoundland.

The vessel was chartered to the Direct United States Cable Company on March 25th for executing repairs, the remuneration for which will be found in the revenue account.

The company's cables and land lines are in good working order, with the exception of the north Placentia cable, which was broken on June 4th.

New offices have been opened in Mark Lane and Tooley Street, London, and at Bradford, Dundee, Edinburgh, Leith, Newcastle-on-Tyne, Havre and Montreal. Direct communication has also been established between the company's offices at Brest and Havre, and the Government office at the Paris Bourse by means of a special wire conceded to the company by the French Government.

Progress has been made since the last report, in the law-suit so long pending between the Anglo Company and the Paris and New York Telegraph Company.

The appeal of the Anglo Company, was argued before the Council of State on May 1st, and the decision of the Council of Prefecture was reversed in this company's favour. The case will now be heard by the Court of Appeal on the question of damages, and it is expected that judgment will be pronounced soon after the termination of the long vacation.

Telephone Company of Ireland.

AT the annual meeting held in Dublin on Wednesday, Alderman DILLON, the chairman, in moving the adoption of the report, said the number of wires last year had been increased by 164, or about 15 per cent. It was intended during the present year to open an exchange between Dublin and Belfast at a tariff of one shilling per message, each lasting three minutes. Towns from Dundalk to Dublin would have a sixpenny rate.

Mr. ARTHUR DUDGEON seconded the motion, which was adopted.

The CHAIRMAN, replying to a shareholder, said the preference dividend would be paid at the end of the year.

United River Plate Telephone Company, Limited.—In their report for the year ended March last, the directors of the United River Plate Telephone Company, Limited, recommend that from an available balance of £4,805, £768 be applied in writing off one-half of the taxes suspense account, £2,000 be written off for bad and doubtful debts in the River Plate, and that the balance of £2,037 be carried forward.

Akester Electric Motor Company.—The annual meeting of this company was held on Tuesday last, at Cannon Street Hotel, for the purpose of receiving the engineer's report. Members of the press were not admitted as the proceedings were of a private nature.

Cuba Submarine Telegraph Company, Limited.—For the past half-year the directors of the Cuba Submarine Telegraph Company, Limited, recommend a dividend at the rate of 8 per cent. per annum.

TRAFFIC RECEIPTS.

The City and South London Railway Company. Traffic receipts for the week, ended July 25th, £686 gross.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 23.)	Closing Quotation. (July 30).	Business done during week ending July 30, 1891. Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	98 —101	98 —101	101½	
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	44½— 45½	43 — 44 xd	44⅞	43
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	83½— 84½	82½— 83½xd	84¾	82½
2,809,310*l*	Do. do. Deferred	Stock	9¾— 10¼	9⅜— 10	10	9⅜
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜— 12¼	11⅜— 12¼	12⅛	12
84,500*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
63,416	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅜— 2⅝	2⅜— 2⅝	2⅜	...
63,416	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅝— 2	1⅝— 2	2	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	4 — 5	4 — 5	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	103 —107	105 —109	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	4 — 5 xd	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 4	3½— 4	3½	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10½— 10¾	10⅝— 10⅝xd	10¾	10⅝
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞— 15⅛	14⅝— 14⅞	15 1/16	14⅝
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 — 110	108 —111	109	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	108½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞—15⅛ xd	14⅞— 15⅛	15⅛	14 13/16
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900; red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	101 —104	102 —105	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	101 —104	101 —104	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	104 —107 xd	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	102	101¾
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	2½— 3½	3 — 4	3 7/16	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2⅜— 2⅝	2⅜— 3	2⅞	2⅜
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3¼— 3⅜	3⅜— 4	3⅜	3½
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¼— 1⅜	1¼— 1⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9⅞	9⅝— 9⅞xd	10	9⅞
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼	14⅞— 15⅛xd	15⅛	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	18½—18⅝	18½— 18⅝	...	...
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11	10 — 11	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½—19½ xd	18½— 19½	19½	19⅜
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9½— 9¾	9½— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9¾— 10¼	9¾— 10¼	...	...
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝— 4⅞ xd	4⅝— 5	4 15/16	4 11/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½—13½ xd	12½— 13½	13⅛	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13 xd	12½— 13	...	...
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	105 —107	105 —107	106½	106
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	3½— 4½	3½— 4½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	5/16— 7/16	5/16— 7/16	...	...
9,000	Reuter's Limited	8	8 — 8½	8 — 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6⅜— 7⅛xd	6½— 7	...	...
7,900	Do. do. do. 7 per cent. pref.	2	3½— 3¾xd	3½— 3⅞	3½	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4⅝	4 11/16
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46 xd	44 — 46	45	44½
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9 xd	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	96 — 99	96 — 99	...	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 — 102	97 —102	...	...
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	10¾— 11¼	11 1/16	11
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6⅞	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4⅛— 4⅜	4⅛— 4⅜	...	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	104 —107	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	105½	...
88,321	West India and Panama Telegraph, Limited	10	2 — 2¼	1⅞— 2⅛	2 1/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10¼	10⅛
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	101 —105	101 —105	...	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	4⅜—5¼	4⅜— 5¼	...	...

* Subject to Founders' Shares.

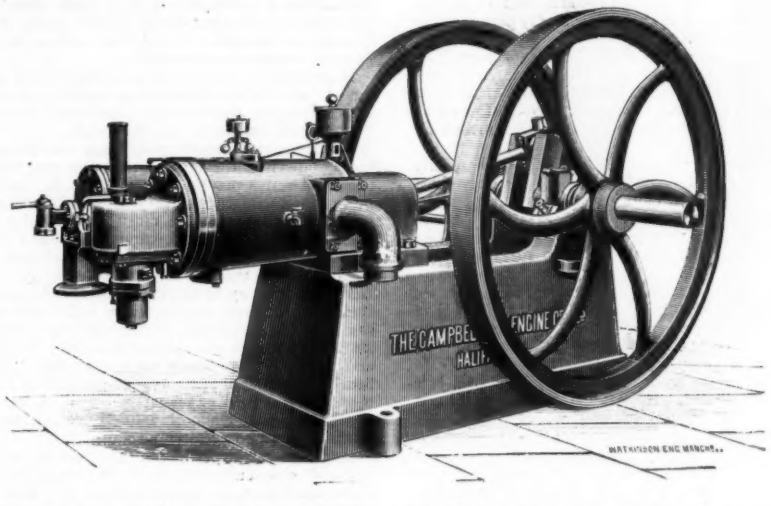
LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅝.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 60—62.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3⅞—4¼.—House to House Company (£5 paid) 4⅜—5¼.—Liverpool Electric Supply, £3 paid, 2⅝—2¾.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅜—2.—Manchester, Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2¼—2⅜.—£5 Preference, fully paid 3⅞—4¼.—Debentures 90—95.—Wards Electric Car, £10 paid, ¾—1.

BANK RATE OF DISCOUNT.—2½ per cent. (2nd July, 1891).

THE CAMPBELL GAS ENGINE.

THE growing popularity of gas engines renders it desirable that the merits of each should be known, and we have pleasure in bringing before our readers a notice of the "Campbell" gas engine, which holds a very high position, the result of eight years experimenting. The engine has been on the market for four years, during which time it has been tried in almost all trades, and on great varieties of work. The engine differs from other makes of gas engines in that it has an ignition at every revolution of the crank when required, and this enables the engine to be made so as to occupy less space, to be of less weight per H.P., and what is more advantageous still, to give regular and more even working than with engines which only have an ignition every two or three revolutions. Then, again, the simplicity of this engine is most marked. There are only two simple valves in it, and these are not subjected to any hard work, and thus do not necessitate renewal or repair. The whole engine is so constructed that it can be cleaned without breaking a single joint, and any labourer or lad can do it quite easily. The ignition is effected by a hot tube, which method Mr. Campbell introduced several years ago, and it is now being adopted by nearly all other makers. The illustration represents a 12 H.P. nominal engine, which will give 26 indicated H.P., with a gas consumption of 18 cubic feet per indicated H.P. per hour. The smallest engine made, ½ H.P. nominal, will give 2¾ H.P. indicated, with a total gas consumption of 55 cubic



feet per hour, or 20 cubic feet per indicated H.P per hour. Two of these engines have been supplied to Her Majesty's War Department, and in each case they have given 1½ brake H.P. This result, for this size of engine, is extremely good, and shows that the mechanical efficiency is high. The gas consumption in this engine is automatically regulated to suit the work which is being done by it. Several of these engines are used for electric lighting, and we think that the engine is deserving of serious consideration by those who are requiring power. We understand that the makers of this engine, the Campbell Gas Engine Company, Limited, Well Lane, Halifax, are extremely busy, and to meet the demand have to work night and day.

ELECTRICAL SIGNALLING.

OUR contemporary, *Industries*, states that the result of the agitation amongst railway servants against overwork was the appointment of a Committee to enquire into their hours. Some of the larger companies thought it impossible to do away with overwork altogether, and when we look into the causes necessitating long hours, this really seems to be the case. Doubtless the signalling system has been repeatedly improved upon by railway engineers, but as far as the present apparatus goes, improvements have not kept pace with the enormous increase in the amount of traffic, which it is estimated amounts to about 700 million passengers annually. Delays are, of course, unavoidable in foggy weather, and even in fine weather it is not surprising that they should occur, when we consider this tremendous traffic. The signalling on most of our English lines is to-day worked on the interlocking principle, and consequently if one train is stopped for any cause, a dozen others may be delayed, thus making the guards and engine drivers later home. It seems, therefore, practically impossible to fix a normal working day unless some important improvement is made in the apparatus for working the trains. It has been noticed how that the inquiries made by the Board of Trade prove that very few accidents are due to overwork on the part of the servants, as in some cases accidents have happened when the men were quite fresh at their work. The signalmen are certainly worse off than the engine drivers, as they not only have to keep their ears and eyes well open, but have also to undergo no small amount of strain on their muscular energies. We should think that this state of affairs might be remedied in some way or other by the use of electricity. Under present circumstances, when once a train has left the starting point, it cannot be communicated with until it reaches the next station. Surely, now that the telephone is getting so well known and used, this means of communication between station master and engine driver would prove advantageous in many ways, and, above all, a more regular service would in this way be procured, and any breakdown or delay would be notified immediately, and even though it might not entirely do away with extra work, it would certainly lessen it very largely. We hope this matter will be taken up by inventors, and with the assistance of the railway companies something satisfactory ought to be settled upon, although the system above stated might not be quite practicable. We feel sure that there would be no more murmuring about over work if an apparatus for this purpose could be adopted.

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY, AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

By NIKOLA TESLA.

(*Continued from page* 108.)

THE above plan necessitates the employment of a primary of comparatively small size, and it is apt to heat when powerful effects are desirable for a certain length of time. In such a case it is better to employ a larger coil, fig. 17B, and introduce it from one side of the tube, until the streams begin to appear. In this case the nearest terminal of the secondary may be connected to the primary or to the ground, which is practically the same thing, if the primary is con-

* A lecture delivered before the American Institute of Electrical Engineers, at Columbia College, N.Y., May 20th, 1891.

nected directly to the machine. In the case of ground connections it is well to determine experimentally the frequency which is best suited under the conditions of the test. Another way of obviating the streams, more or less, is to make the primary in sections and supply it from separate well insulated sources.

In many of these experiments, when powerful effects are wanted for a short time, it is advantageous to use iron cores with the primaries. In such case a very large primary coil may be wound and placed side by side with the secondary, and, the nearest terminal of the latter being connected to the primary, a laminated iron core is introduced through the primary into the secondary as far as the streams will permit. Under these conditions an excessively powerful brush, several inches long, which may be appropriately called "St. Elmo's

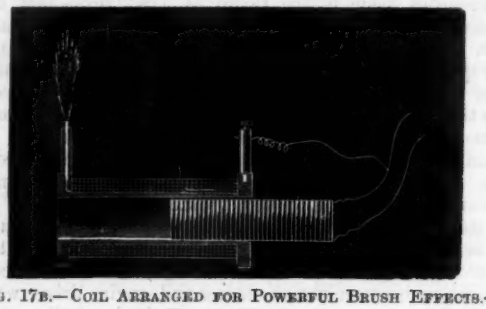


FIG. 17B.—COIL ARRANGED FOR POWERFUL BRUSH EFFECTS.—ST. ELMO'S HOT FIRE.

hot fire," may be caused to appear at the other terminal of the secondary, producing striking effects. It is a most powerful ozoniser, so powerful, indeed, that only a few minutes are sufficient to fill the whole room with the smell of ozone, and it undoubtedly possesses the quality of exciting chemical affinities.

For the production of ozone, alternating currents of very high frequency are eminently suited, not only on account of the advantages they offer in the way of conversion, but also because of the fact, that the ozonising action of a discharge is dependent on the frequency as well as on the potential, this being undoubtedly confirmed by observation.

In these experiments, if an iron core is used it should be carefully watched, as it is apt to get excessively hot in an incredibly short time. To give an idea of the rapidity of the heating, I will state, that by passing a powerful current through a coil with many turns, the inserting within the same of a thin iron wire for no more than one second's time is sufficient to heat the wire to something like 100° C.

But this rapid heating does not need to discourage us in the use of iron cores in connection with rapidly alternating currents. I have for a long time been convinced, that in the industrial distribution by means of transformers, some such plan as the following might be practicable. We may use a comparatively small iron core, subdivided, or perhaps not even subdivided. We may surround this core with a considerable thickness of material which is fireproof and conducts the heat poorly, and on top of that we may place the primary and secondary windings. By using either higher frequencies or greater magnetising forces, we may by hysteresis and eddy currents heat the iron core so far as to bring it nearly to its maximum permeability, which, as Hopkinson has shown, may be as much as sixteen times greater than that at ordinary temperatures. If the iron core were perfectly enclosed it would not be deteriorated by the heat, and, if the enclosure of fireproof material would be sufficiently thick, only a limited amount of energy could be radiated in spite of the high temperature. Transformers have been constructed by me on that plan, but for lack of time no thorough tests have as yet been made.

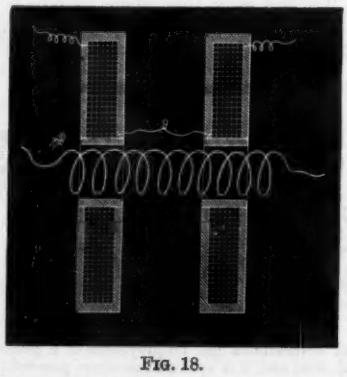


FIG. 18.

COIL FOR PRODUCING VERY HIGH DIFFERENCE OF POTENTIAL.

Another way of adapting the iron core to rapid alternations, or, generally speaking, reducing the frictional losses, is to produce by continuous magnetisation a flow of something like 7,000 or 8,000 lines per square centimetre through the core, and then work with weak magnetising forces and preferably high frequencies around the point of greatest permeability. A higher efficiency of conversion and greater output are obtainable in this manner. I have also employed this principle in connection with machines in which there is no reversal of polarity. In these types of machines, as long as there are only few pole projections, there is no great gain, as the maxima and minima of magnetisation are far from the point of maximum permeability; but when the number of the pole projections is very great, the required rate of change may be obtained, without the magnetisation varying so far as to depart greatly from the point of maximum permeability, and the gain is considerable.

The above described arrangements refer only to the use of commercial coils as ordinarily constructed. If it is desired to construct a coil for the express purpose of performing with it such experiments as I have described, or, generally, rendering it capable of withstanding the greatest possible difference of potential, then a construction as indicated in fig. 18 will be found of advantage. The coil in this case is formed of two independent parts which are wound oppositely, the connection between both being made near the primary. The potential in the middle being zero, there is not much tendency to jump to the primary and not much insulation is required. In some cases, the middle point may, however, be connected to the primary or to the ground. In such a coil the places of greatest difference of potential are far apart and the coil is capable of withstanding an enormous strain. The two parts may be movable so as to allow a slight adjustment of the capacity effect.

As to the manner of insulating the coil, it will be found convenient to proceed in the following way: First, the wire should be boiled in paraffin, until all the air is out; then the coil is wound by running the wire through melted paraffin, merely for the purpose of fixing the wire. The coil is then taken off from the spool, immersed in a cylindrical vessel filled with pure melted wax and boiled for a long time until the bubbles cease to appear. The whole is then left to cool down thoroughly, and then the mass is taken out of the vessel and turned up in a lathe. A coil made in this manner, and with care, is capable of withstanding enormous potential differences.

It may be found convenient to immerse the coil in paraffin oil, or some other kind of oil; it is a most effective way of insulating, principally on account of the perfect exclusion of air, but it may be found that, after all, a vessel filled with oil is not a very convenient thing to handle in a laboratory.

If an ordinary coil can be dismounted, the primary may be taken out of the tube and the latter plugged up on one end, filled with oil, and the primary re-inserted. This affords an excellent insulation, and prevents the formation of the streams.

Of all the experiments which may be formed with rapidly alternating currents, the most interesting are those which concern the production of a practical illuminant. It cannot be denied that the present methods, though they were brilliant advances, are very wasteful. Some better methods must be invented, some more perfect apparatus devised. Modern research has opened new possibilities for the production of an efficient source of light, and the attention of all has been turned in the direction indicated by able pioneers. Many have been carried away by the enthusiasm and passion to discover, but in their zeal to reach results, many have been misled. Starting with the idea of producing electro-magnetic waves, they turned their attention, perhaps too much to the study of electro-magnetic effects, and neglected the study of electrostatic phenomena. Naturally, nearly every investigator availed himself of an apparatus similar to that used in earlier experiments. But in those forms of apparatus, while the electro-magnetic inductive effects are enormous, the electrostatic effects are excessively small.

In the Hertz experiments, for instance, a high tension induction coil is short circuited by an arc, the resistance of which is very small, the smaller the more capacity is attached to the terminals; and the difference of potential at these is enormously diminished. On the other hand, when the discharge is not passing between the terminals, the static effects may be considerable, but only qualitatively so, not quantitatively, since their rise and fall is very sudden, and since their frequency is small. In neither case, therefore, are powerful electrostatic effects perceivable. Similar conditions exist when, as in some interesting experiments of Dr. Lodge, Leyden jars are discharged disruptively. It has been thought—and I believe asserted—that in such cases most of the energy is radiated into space. In the light of the experiments which I have described above, it will now not be thought so. I feel safe in asserting that in such cases most of the energy is partly taken up and converted into heat in the arc of the discharge and in the conducting and insulating material of the jar, some energy being, of course, given off by electrification of the air; but the amount of the directly radiated energy is very small.

When a high tension induction coil, operated by currents alternating only 20,000 times a second, has its terminals closed through even a very small jar, practically all the energy passes through the dielectric of the jar, which is heated, and the electrostatic effects manifest themselves outwardly only to a very weak degree. Now the external circuit of a Leyden jar, that is, the arc and the connections of the coatings, may be looked upon as a circuit generating alternating currents of excessively high frequency and fairly high potential, which is closed through the coatings and the dielectric between them, and from the above it is evident that the external electrostatic effects must be very small, even if a recoil circuit be used. These conditions make it appear that with the apparatus usually at hand, the observation of powerful electrostatic effects was impossible, and what experience has been gained in that direction is only due to the great ability of the investigators.

But powerful electrostatic effects are a *sine qua non* of light production on the lines indicated by theory. Electro-magnetic effects are primarily unavailable, for the reason that to produce the required effects we would have to pass current impulses through a conductor which, long before the required frequency of the impulses could be reached, would cease to transmit them. On the other hand, electro-

magnetic waves many times longer than those of light, and producible by sudden discharges of a condenser, could not be utilised, it would seem, except we avail ourselves of their effect upon conductors as in the present methods, which are wasteful. We could not affect by means of such waves the static molecular or atomic charges of a gas, cause them to vibrate and to emit light. Long transverse waves cannot, apparently, produce such effects, since excessively small electro-magnetic disturbances may pass readily through miles of air. Such dark waves, unless they are of the length of true light waves, cannot, it would seem, excite luminous radiation in a Geissler tube, and the luminous effects, which are producible by induction in a tube devoid of electrodes, I am inclined to consider as being of an electrostatic nature.

To produce such luminous effects, straight electrostatic thrusts are required; these, whatever be their frequency may disturb the molecular charges and produce light. Since current impulses of the required frequency cannot pass through a conductor of measurable dimensions, we must work with a gas, and then the production of powerful electrostatic effects becomes an imperative necessity.

It has occurred to me, however, that electrostatic effects are in many ways available for the production of light. For instance, we may place a body of some refractory material in a closed, and preferably more or less exhausted, globe, connect it to a source of high, rapidly alternating, potential, causing the molecules of the gas to strike it many times a second at enormous speeds, and in this manner, with trillions of invisible hammers, pound it until it gets incandescent; or, we may place a body in a very highly exhausted globe, in a non-striking vacuum, and, by employing very high frequencies and potentials, transfer sufficient energy from it to other bodies in the vicinity, or in general to the surroundings, to maintain it at any degree of incandescence; or, we may, by means of such rapidly alternating high potentials, disturb the ether carried by the molecules of a gas on their static charges, causing them to vibrate and to emit light.

But, electrostatic effects being dependent upon the potential and frequency to produce the most powerful action, it is desirable to increase both as far as practicable. It may be possible to obtain quite fair results by keeping either of these factors small, provided the other is sufficiently great; but we are limited in both directions. My experience demonstrates that we cannot go below a certain frequency, for, first, the potential then becomes so great that it is dangerous; and, secondly, the light production is less efficient.

I have found that, by using the ordinary low frequencies, the physiological effect of the current required to maintain at a certain degree of brightness a tube 4 feet long, provided at the ends with outside and inside condenser coatings, is so powerful that, I think, it might produce serious injury to those not accustomed to such shocks; whereas, with 20,000 alternations per second, the tube may be maintained at the same degree of brightness without any effect being felt. This is due principally to the fact that a much smaller potential is required to produce the same light effect, and also to the higher efficiency in the light production. It is evident that the efficiency in such cases is the greater the higher the frequency, for the quicker the process of charging and discharging the molecules, the less energy will be lost in the form of dark radiation. But, unfortunately, we cannot go beyond a certain frequency on account of the difficulty of producing and conveying the effects.

I have stated above that a body enclosed in an unexhausted bulb may be intensely heated by simply connecting it with a source of rapidly alternating potential. The heating in such a case is, in all probability, due mostly to the bombardment of the molecules of the gas contained in the bulb. When the bulb is exhausted, the heating of the body is much more rapid, and there is no difficulty whatever in bringing a wire or filament to any degree of incandescence by simply connecting it to one terminal of a coil of the proper dimensions. Thus, if the well-known apparatus of Prof. Crookes, consisting of a bent platinum wire with vanes mounted over it (fig. 19), be

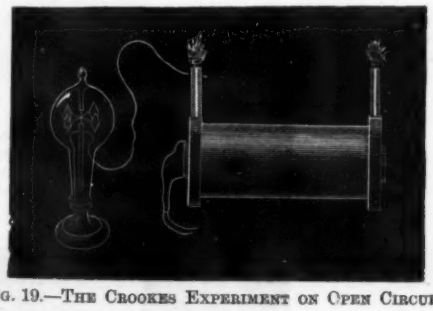


FIG. 19.—THE CROOKES EXPERIMENT ON OPEN CIRCUIT.

connected to one terminal of the coil—either one or both ends of the platinum wire being connected—the wire is rendered almost instantly incandescent, and the mica vanes are rotated as though a current from a battery were used. A thin carbon filament, or, preferably, a button of some refractory material (fig. 20), even if it be a comparatively poor conductor, enclosed in an exhausted globe, may be rendered highly incandescent; and in this manner a simple lamp, capable of giving any desired candle-power, is provided.

The success of lamps of this kind would depend largely on the selection of the light-giving bodies contained within the bulb. Since, under the conditions described, refractory bodies—which are very poor conductors, and capable of withstanding for a long time excessively high degrees of temperature—may be used, such illuminating devices may be rendered successful

It might be thought at first that if the bulb, containing the filament or button of refractory material, be perfectly well exhausted—that is, as far as it can be done by the use of the best apparatus—the heating would be much less intense, and that in a perfect vacuum it could not occur at all. This is not confirmed by my experience; quite the contrary, the better the vacuum the more easily the bodies are brought to incandescence. This result is interesting for many reasons.

At the outset of this work the idea presented itself to me whether two bodies of refractory material enclosed in a bulb exhausted to such a degree that the discharge of a large induction coil, operated in the usual manner, cannot pass through, could be rendered incandescent by mere condenser action. Obviously, to reach this result enormous potential differences and very high frequencies are required, as is evident from a simple calculation.

But such a lamp would possess a vast advantage over an ordinary incandescent lamp in regard to efficiency. It is well known that the efficiency of a lamp is to some extent a function of the degree of incandescence, and that, could we but work a filament at many times higher degrees of incandescence, the efficiency would be much greater. In an ordinary lamp this is impracticable

FIG. 20.—LAMP WITH SINGLE BLOCK OF REFRACTORY MATERIAL.

FIG. 21.—LAMP WITH TWO FILAMENTS IN HIGHEST VACUUM WITH LEADING-IN WIRES.

on account of the destruction of the filament, and it has been determined by experience how far it is advisable to push the incandescence. It is impossible to tell how much higher efficiency could be obtained if the filament could withstand indefinitely, as the investigation to this end obviously cannot be carried beyond a certain stage; but there are reasons for believing that it would be very considerably higher. An improvement might be made in the ordinary lamp by employing a short and thick carbon; but then the leading-in wires would have to be thick, and, besides, there are many other considerations which render such a modification entirely impracticable. But in a lamp as above described, the leading-in wires may be very small, the incandescent refractory material may be in the shape of blocks offering a very small radiating surface, so that less energy would be required to keep them at the desired incandescence; and in addition to this, the refractory material need not be carbon, but may be manufactured from mixtures of oxides, for instance, with carbon or other material, or may be selected from bodies which are practically non-conductors, and capable of withstanding enormous degrees of temperature.

All this would point to the possibility of obtaining a much higher efficiency with such a lamp than is obtainable in ordinary lamps. In my experience it has been demonstrated that the blocks are brought to high degrees of incandescence with much lower potentials than those determined by calculation, and the blocks may be set at greater distances from each other. We may freely assume, and it is probable, that the molecular bombardment is an important element in the heating, even if the globe be exhausted with the utmost care, as I have done; for although the number of the molecules is, comparatively speaking, insignificant, yet on account of the mean free path being very great, there are fewer collisions, and the molecules may reach much higher speeds, so that the heating effect due to this cause may be considerable, as in the Crookes experiments with radiant matter.

But it is likewise possible that we have to deal here with an increased facility of losing the charge in very high vacuum, when the potential is rapidly alternating, in which case most of the heating would be directly due to the surging of the charges in the heated bodies. Or else the observed fact may be largely attributable to the effect of the points which I have mentioned above, in consequence of which the blocks or filaments contained in the vacuum are equivalent to condensers of many times greater surface than that calculated from their geometrical dimensions. Scientific men still differ in opinion as to whether a charge should, or should not, be lost in a perfect vacuum, or in other words, whether ether is, or is not, a conductor. If the former were the case, then a thin filament enclosed in a perfectly exhausted globe, and connected to a source of enormous, steady potential, would be brought to incandescence.

Various forms of lamps on the above described principle, with the refractory bodies in the form of filaments, fig. 21, or blocks,

fig. 22, have been constructed and operated by me, and investigations are being carried on in this line. There is no difficulty in reaching such high degrees of incandescence that ordinary carbon is to all appearance melted and volatilised. If the vacuum could be made absolutely perfect, such a lamp, although inoperative with apparatus ordinarily used, would, if operated with currents of the required character, afford an illuminant which would never be destroyed, and which would be far more efficient than an ordinary incandescent lamp. This perfection can, of course, never be reached, and a very slow destruction and gradual diminution of the size always occurs, as in incandescent lamps; but there is no possibility of a sudden and premature disabling which occurs in the latter by the breaking of the filament, especially when the incandescent bodies are n the shape of blocks.

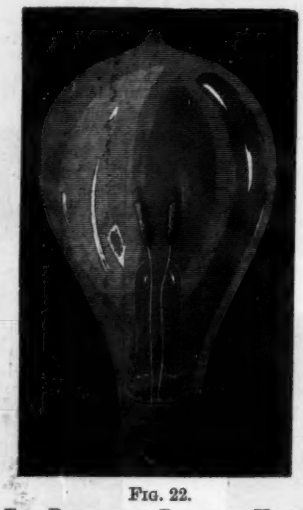


FIG. 22.
LAMP WITH TWO REFRACTORY BLOCKS IN HIGHEST VACUUM.

With these rapidly alternating potentials there is, however, no necessity of enclosing two blocks in a globe, but a single block, as in fig. 20, or filament, fig. 23, may be used. The potential in this case must of course be higher, but it is easily obtainable, and besides it is not necessarily dangerous.

The facility with which the button or filament in such a lamp is brought to incandescence, other things being equal, depends on the size of the globe. If a perfect vacuum could be obtained, the size of the globe would not be of importance, for then the heating would be

FIG. 23.—LAMP WITH SINGLE STRAIGHT FILAMENT AND ONE LEADING-IN WIRE.

wholly due to the surging of the charges, and all the energy would be given off to the surroundings by radiation. But this can never occur in practice. There is always some gas left in the globe, and although the exhaustion may be carried to the highest degree, still the space inside of the bulb must be considered as conducting when such high potentials are used, and I assume that, in estimating the energy that may be given off from the filament to the surroundings, we may consider the inside surface of the bulb as one coating of a condenser, the air and other objects surrounding the bulb forming the other coating. When the alternations are very low there is no doubt that a considerable portion of the energy is given off by the electrification of the surrounding air.

In order to study this subject better, I carried on some experiments with excessively high potentials and low frequencies. I then observed that when the hand is approached to the bulb—the filament being connected with one terminal of the coil—a powerful vibration is felt, being due to the attraction and repulsion of the molecules of the air which are electrified by induction through the glass. In some cases, when the action is very intense, I have been able to hear a sound, which must be due to the same cause.

When the alternations are low, one is apt to get an excessively powerful shock from the bulb. In general, when one attaches bulbs or objects of some size to the terminals of the coil, one should look out for the rise of potential, for it may happen that by merely connecting a bulb or plate to the terminal, the potential may rise to many times its original value. When lamps are attached to the terminals, as illustrated in fig. 24, then the capacity of the bulbs should be such

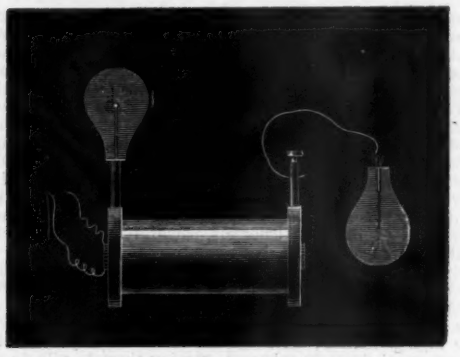


FIG. 24.—LAMPS WITH ONE LEADING-IN WIRE RENDERED INCANDESCENT.

as to give the maximum rise of potential under the existing conditions. In this manner one may obtain the required potential with fewer turns of wire.

The life of such lamps as described above depends, of course, largely on the degree of exhaustion, but to some extent also on the shape of the block of refractory material. Theoretically it would seem that a small sphere of carbon enclosed in a sphere of glass would not suffer deterioration from molecular bombardment, for, the matter in the globe being radiant, the molecules would move in straight lines, and would seldom strike the sphere obliquely. An interesting thought in connection with such a lamp is that in it "electricity" and electrical energy apparently must move in the same lines.

The use of alternating currents of very high frequency makes it possible to transfer, by electrostatic or electro-magnetic induction through the glass of a lamp, sufficient energy to keep a filament at incandescence and so do away with the leading-in wires. Such lamps have been proposed, but for want of proper apparatus they have not been successfully operated. Many forms of lamps on this principle with continuous and broken filaments have been constructed by me and experimented upon. When using a secondary enclosed within the lamp, a condenser is advantageously combined with the secondary. When the transference is effected by electrostatic induction, the potentials used are, of course, very high with frequencies obtainable from a machine. For instance, with a condenser surface of 40 centimetres square, which is not impracticably large, and with glass of good quality 1 mm. thick, using currents alternating 20,000 times a second, the potential required is approximately 9,000 volts. This may seem large, but since each lamp may be included in the secondary of a transformer of very small dimensions, it would not be inconvenient, and, moreover, it would not produce fatal injury. The transformers would all be preferably in series. The regulation would offer no difficulties, as with currents of such frequencies it is very easy to maintain a constant current.

In the accompanying engravings some of the types of lamps of this kind are shown. Fig. 25 is such a lamp with a broken filament, and

FIG. 25.—LAMP WITH TWO BLOCKS OR FILAMENTS AND A PAIR OF INDEPENDENT INSIDE AND OUTSIDE CONDENSER COATINGS.

fig. 26A and 26B one with a single outside and inside coating and a single filament. I have also made lamps with two outside and inside coatings and a continuous loop connecting the latter. Such lamps have been operated by me with current impulses of the enormous frequencies obtainable by the disruptive discharge of condensers.

The disruptive discharge of a condenser is especially suited for operating such lamps—with no outward electrical connections—by

means of electro-magnetic induction, the electro-magnetic inductive effects being excessively high; and I have been able to produce the desired incandescence with only a few short turns of wire. Incandescence may also be produced in this manner in a simple closed filament.

FIG. 26A. FIG. 26B.

LAMP WITH ONE FILAMENT, ONE INSIDE AND ONE OUTSIDE CONDENSER COATING.

Leaving now out of consideration the practicability of such lamps, I would only say that they possess a beautiful and desirable feature, namely, that they can be rendered, at will, more or less brilliant

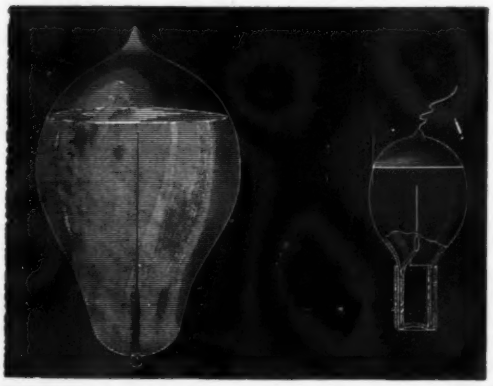


FIG. 27.—LAMP WITH ONE FILAMENT AND LEADING-IN WIRE AND EXTERNAL CONDENSER COATING.

FIG. 28.—LAMP WITH ONE FILAMENT, ONE INSIDE AND ONE OUTSIDE CONDENSER COATING, AND AUXILIARY COATING

simply by altering the relative position of the outside and inside condenser coatings, or inducing and induced circuits.

When a lamp is lighted by connecting it to one terminal only of the source, this may be facilitated by providing the globe with an outside condenser coating, which serves at the same time as a reflector, and connecting this to an insulated body of some size.

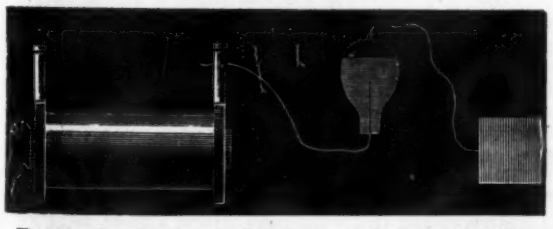


FIG. 29.—INCREASING THE BRILLIANCY OF LAMP ON ONE WIRE.

Lamps of this kind are illustrated in fig. 27 and fig. 28. Fig. 29 shows the plan of connections. The brilliancy of the lamp may, in this case, be regulated within wide limits by varying the size of the insulated metal plate to which the coating is connected.

(To be continued.)

NEW PATENTS—1891.

11,447. "Improvements in electric arc lamps." H. D. NORMAN and H. A. PAYNE. Dated July 6th.

11,473. "Improvements in alternating current electro-magnetic motors." H. H. LAKE. (Communicated by N. Tesla, United States.) Dated July 6th. *(Complete.)*

11,476. "An improvement in key or switch sockets for electric lamps." R. J. BOTT. Dated July 6th.

11,497. "An hydro-electric lift." J. MCLAREN. Dated July 7th.

11,519. "Improvements in diaphragms for electric cells." E. A. LE SUEUR. Dated July 7th. *(Complete.)*

11,526. "Improvements in and connected with portable electric lamps, and in primary batteries and lenses for deflecting light to be used therewith." F. G. W. J. ADAMS. Dated July 7th.

11,538. "An electric traction magnetic conductor." G. PROKOFIEW. Dated July 7th.

11,539. "An improved dynamo machine." G. PROKOFIEW. Dated July 7th.

11,560. "Improvements in and relating to galvanic batteries." G. G. M. HARDINGHAM. (Communicated by J. R. Hard and H. Connett, United States.) Dated July 7th.

11,576. "Improvement in alarm signalling apparatus." D. TULEY. Dated July 8.

11,601. "Improvements in phonautographic and phonographic 'forms' or material for the recording of sound vibrations." C. ADAMS-RANDALL. Dated July 8th.

11,620. "Improvements in apparatus for preparing bleaching solution and bleaching powder by electrolysis." E. E. LEVER. Dated July 8th.

11,625. "Improvements in the method of and apparatus for making electrical connections." J. H. HOLMES. Dated July 8th.

11,630. "Improvements in and connected with moulds, rolls, or dies for manufacturing metallic plates or boxes, the said plates or boxes being more especially intended for use in electrical secondary batteries." A. S. BOWER. Dated July 8th.

11,642. "An improved water and fireproof fibrous material suitable for the manufacture of plain or decorated wall, ceiling, or floor linings, electrical and other conduits, bases, and coverings, and numerous other purposes for which wood, paper, plaster and cement are now used." H. HEARTFIELD. Dated July 8th.

11,644. "Improvements in the lighting of trains by electricity." I. A. TIMMIS. Dated July 8th.

11,645. "Improvements relating to combination gas and electric fittings, and to gas fittings." R. B. EVERED and T. RUDLING. Dated July 8th.

11,668. "Electric lighting of ships' compasses transparent cards." J. PARKES. Dated July 9th.

11,712. "Improvements in or connected with electric batteries." H. C. BULL. Dated July 9th.

11,720. "Improvements in electrical switches." J. H. TUCKER. Dated July 9th.

11,746. "Improvements in telegraphic apparatus." F. VAN HOUTEN. Dated July 9th. *(Complete.)*

11,756. "Improvements in electrical railway signalling." W. BROCK and W. H. R. SAUNDERS. Dated July 9th.

11,767. "Improvements in telephone switchboards." J. E. KINGSBURY. Dated July 9th.

11,801. "Improvements in the manufacture of insulating conduits or coverings for electric conductors." R. D. HAINES. Dated July 11th. [Date applied for under Patents Act, 1883, Sec. 102, 12th December, 1890, being date of application in United States.]

11,804. "A mechanical liqueur telephone." H. P. ADE. Dated July 11th.

11,886. "Improvements in electric arc lamps." A. CANCE and SOCIETE ANONYME D'APPAREILLAGES AND D'ECLAIRAGES ELECTRIQUES (LAMPES ELECTRIQUES CANCE). Dated July 13th.

11,891. "Improvements in and relating to switch devices for effecting the connections in telephone systems." W. P. THOMPSON. (Communicated by J. Dietz, Germany.) Dated July 13th. *(Complete.)*

11,978. "A system and apparatus for the evolution and diffusion, by electrical energy, of disinfectants, antiseptics, and substances of a like nature." A. R. UPWARD. Dated July 15th.

12,005. "Improvements in cable railways or tramways for recreative and other purposes." J. W. SMITH. Dated July 15th.

12,014. "Improvements in telephonic transmitters." A. T. COLLIER, A. MARR, and W. F. BOTTOMLEY. Dated July 15th.

12,018. "Improvements in electrical gear for steering ships, and controlling the movement of holophotes, guns, and the like." E. WILSON. Dated July 15th.

12,019. "Improvements in the manufacture of carbons for electric arc lamps." W. L. WISE. (Communicated by the Rheinische Fabrik for Elektrische Bogenlichtkohle W. Grüdelbach, Germany.) Dated July 15th.

12,036. "Improvements in primary batteries." S. W. MAQUAY. Dated July 15th.

12,040. "Improvements in voltmeters." A. H. DYKES and W. B. HIBD. Dated July 15th.

12,046. "Improvements in or relating to electric motors." J. SAHULKA. Dated July 15th. *(Complete.)*

12,069. "An improved electrode plate for electric collectors." H. D. FITZPATRICK. (Communicated by K. F. Schöller and R. H. Jahr, Germany.) Dated July 16th. *(Complete.)*

12,070. "An improved method of reciprocating the anchor of an electric apparatus." H. D. FITZPATRICK. (Communicated by K. F. Schöller and R. H. Jahr, Germany.) Dated July 16th. (*Complete.*)

12,099. "Improvements in electric motors." S. W. MAQUAY. Dated July 16th.

12,106. "Improvements in and relating to electric lamps or lighting apparatus." F. V. MAQUAIRE. Dated July 16th.

12,107. "Improvements in drops or suspending mechanism for electric light and other like fittings." W. E. Dow. Dated July 16th. (*Complete.*)

12,108. "Improvements in hydraulic motors." G. R. BODMER. Dated July 16th.

12,117. "Improvements in electric current meters." E. HARTMANN and W. BRAUN. Dated July 16th. (*Complete.*)

12,133. "Improvements in the automatic contacts of incandescent lamp holders." R. J. BOTT. Dated July 17th.

12,150. "An improved electro-motor adapted to clockwork machinery." W. R. MAY. Dated July 17th.

12,188. "Improvements in and in connection with incandescent electric lamps." R. H. BARRETT. Dated July 17th.

12,243. "Improvements in magnetic compasses." P. J. KAISER. Dated July 18th. (*Complete.*)

12,244. "Improvements in portable electric lamps." J. S. NETTLEFOLD. Dated July 18th.

12,257. "Improvements in the manufacture of electric incandescence or glow lamps." P. SCHARF and R. LATZKO. Dated July 18th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

6,667. "An electric meter." A. FRAGER. Dated April 30th. 8d. Relates to the construction of electric meter for measuring electrical energy, as described in Patent No. 8,958 of 1889. The present improvements relate chiefly to the arrangement for suspending in an adjustable manner the bobbin of the watt or ampèremeter described in the said specification, within its solenoid coils. 4 claims.

8,031. "Improvements in and relating to printing-telegraphs and to the distribution of news transmitted thereby." R. D. RADCLIFFE. Dated May 22nd. 8d. The inventor employs in printing-telegraph machines suitable ink, which will permit of the messages or news recorded thereby being multiplied or copied by means of gelatine, lithographic stones or otherwise. 3 claims.

8,477. "Improvements in electric switches or apparatus for making and breaking electric circuits." S. F. BEEVOR. Dated May 31st. 8d. The inventor encloses the metallic parts by a flexible or collapsible envelope of insulating material, one end of which is attached to the part which forms or carries one of the two metallic contact surfaces, while the other end is attached to the part which carries the other metallic contact surface. 3 claims.

19,037. "Improvements relating to magnetic compasses." J. S. GISBORNE. Dated November 24th. 4d. Claim:—The protecting of magnetic needles from local attraction and influence of iron by controlling or neutralising the polarity of the two isolated iron wires by means of an electric current, substantially as described.

CORRESPONDENCE.

The Values of γ and J—Careless Reading.

If the writer of the article under the above heading, which appeared in your issue of July 24th, had understood the art of controversial writing, he would have carefully eschewed personalities and stuck to facts, reasons and arguments, which are conspicuous chiefly by their absence. It is not I but the writer himself who has been guilty of carelessly reading and studying the subject under discussion. I feel sure you will grant me the small space required to prove the truth of this assertion.

If your reviewer had been more in touch with the engineering professional world he would have known that the result of equation (32) has been regarded as a strong corroboration of the correctness of Joule's value of J.

I have not given Maxwell's formula for calculating t_o. The formula quoted is the formula of Boyle and Marriotte, which Maxwell used. The statement made by me that "this method of calculation applies to all gases" is simply a statement of the law of Boyle and Marriotte expressed by the equation $p\,v = a\,t$. Thus, if p_o, v_o, t_o be other values of the variables, we have—

$$\frac{p\,v}{p_o\,v_o} = \frac{t}{t_o},$$

so that, although a varies for different gases, the value of the ratio on the left is, for all perfect gases, equal to the ratio of the absolute temperatures, and therefore if the pressure is constant, the ratio, E, of the volume at the temperature of boiling water under atmospheric pressure to the volume at the temperature of melting ice, is the same for all gases. The slight difference, therefore, between Regnault's value of E, for air and hydrogen is simple due to experimental errors. The absolute temperature of melting ice can be calculated by the law of Boyle and Marriotte, by the observation of the rise of pressure, due to rise of temperature at constant volume, as well as by the observation of the increase of volume at constant pressure, or by observing the increments of volume and pressure, when both vary. I have read the description of the porous plug and paddle experiments in the "Encyclopædia Britannica," and Maxwell's comments thereon, but fail to see what new light can be thrown on the subject in general by the results of experiments of this kind, or how the results can have anything to do with the determination of the absolute temperature of melting ice, even if the results were, as most assuredly they are not, reliable. I regret that your reviewer's criticisms compel me to point out another error committed by Sir William Thomson. Why should the correction—leaving out of consideration the fact that the true value of E is the same for all perfect gases—be a deduction from the value of t_o calculated by the law of Boyle and Marriotte by means of Regnault's value of E in the case of hydrogen, and an addition in the case of air? Since Regnault's value of the factor $\frac{k}{\pi\,v_o}$ for air, which differs from his value for hydrogen by about one-half per cent., has been used, his value for the factor $\frac{100}{E}$ for air, not for hydrogen, should have been used also; but then the resulting value of t_o would have been 272·73°. As Sir William Thomson has not deemed a difference of one-half per cent., a matter of importance in the case of the factor $\frac{k}{\pi\,v_o}$, it is difficult to understand his motive for devoting several pages of the "Encyclopædia Britannica" to an attempt to prove that the temperature of melting ice determined by the law of Boyle and Marriotte is liable to a correction amounting to less than $\frac{1}{270}$th per cent. of its value.

In the second of the letters which are the subject of the criticism of the reviewer, I said that in the course of my researches I had met with many amazing statements, but none so amazing as the statement that $\pi\,\frac{d\,t}{d\,p}$ is a constant negative abstract number. Your reviewer, however, has beaten the record by his statement that E and v_o are mutually interdependent variables. He must read more carefully Sir William Thomson's definition of E, and his quotations from Regnault's experiments. The value of E, the coefficient of expansion at constant pressure due to a rise of temperature from freezing to boiling point is the same for all pressures and volumes.

I have not imagined that $d\,t$ and $d\,p$ are the simultaneous increments of temperature and pressure. They represent simultaneous changes, and are either both positive or both negative, so that in both cases $\frac{d\,t}{d\,p}$ is positive. It has been demonstrated by analytical proof that t varies as $p^{\frac{\gamma-1}{\gamma}}$, when the changes are adiabatic, without reference to the results of any experiments except those by which the truth of the law of Boyle and Marriotte was established. If the observed variation of the temperature corresponding to a decrease of pressure of three atmospheres in the porous plug experiments amounted to less than one-tenth of a degree, the result proved that the method of conducting the experiments was utterly unreliable. If the exact value of γ was known, the adiabatic changes of temperature could be exactly calculated either from observed changes of volume or of pressure. It is stated in Maxwell's work on heat, and I think in Sir William Thomson's article in the "Encyclopædia Britannica," that Joule has proved that when gases expand without doing work there is no change of temperature. Joule could not have proved this experimentally, because under no possible conditions can a gas expand without doing work.

William Donaldson.

July 28th, 1891.